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14.

Preliminary List of Bermuda Deep-sea Fish.[1]

Based on the Collections from Fifteen Hundred Metre-net Hauls, Made in an Eight-mile Circle South of Nonsuch Island, Bermuda.

WILLIAM BEEBE

Director, Department of Tropical Research,
New York Zoological Society

In the course of the oceanographic work of the Department of Tropical Research of the New York Zoological Society during the last nine years off the southern coast of Bermuda, we have concentrated our investigations on an eight-mile circle, the center of which is at 32° 12′ North Latitude, and 64° 36′ West Longitude, and nine miles south-southeast of Nonsuch Island.

In this circle Net Number 1 was drawn at a depth of 400 fathoms on April 3, 1929. Since that time on all possible occasions intensive trawling has been carried on in this same locality from the surface to a depth of 1,400 fathoms. More than 1,500 metre-net hauls have been made, besides 16 descents in the bathysphere from 250 to 3,028 feet.

Only about half of the captured fish have been monographed, but the work is progressing rapidly. We have often been asked for a general list or résumé of the deep-sea fish thus far taken within this circle, so without waiting for completion of study of all the forms I have compiled a preliminary check-list of names and numbers. The hundred-odd pelagic species have not been considered in this catalogue, and so far no attempt has been made to do any dredging on the bottom, so that our list excludes all strictly surface forms as well as abyssal flounders, bottom-living macrurids, etc.

A single sentence will show the value of this concentrated research: The volume of this eight-mile circle is one five-millionth of the volume of the seas of the world, while in it we have taken more than one-third of all the corresponding abyssal fish so far known to science. More specifically, from this extremely limited area we have brought up fishes representing at least 10 Orders, 46 Families, 65 Genera, 220 Species and 115,747 Individuals, almost all from depths below 300 or 400 fathoms, in strictly abyssal habitats. Thirty-one of these species have been described as new.

While it is not my intention at present to make any comparative study between these deep-sea fish and surface or shore forms, or between those taken at various depths, yet a few facts will help to make more real the fish fauna of this area. Members of the genus *Cyclothone* of the family Gonostomidae are among the smallest and the most delicate of all abyssal fish, and within our circle they are far and away the most abundant. If we consider only two species, *C. microdon* and *C. braueri*, which thus comprise less than 1%

[1] Contribution No. 529, Department of Tropical Research, New York Zoological Society. Contribution from the Bermuda Biological Station for Research, Inc.

of the whole, we find that in total numbers they compose four-fifths or 82% (94,684) of all the other deep-sea individual fish together.

Myctophidae or lantern-fish come next in abundance but with wholly different relative proportions. The 57 species of this family compose one-quarter of the whole, and their numbers amount to 10%. Still a third different ratio of factors is shown by Melanostomiatidae, which, with 36 species (16%), can show only 247 individuals, or a mere two-tenths of one per-cent.

The drastic effect on physical characters of fish entering and living under the conditions of darkness, great pressure and frigidity of the abysses of ocean is evident when we realize that out of the 46 families, only 5 contain true surface-living members. These are Anguillidae, Gadidae, Trichiuridae, Brotulidae and Ogcocephalidae.

Considering abundance of individuals the following 10 families are in the lead: Gonostomatidae, Myctophidae, Sternoptychidae, Melamphaeidae, Chauliodontidae, Paralepidae, Maurolicidae, Melanostomiatidae, Aceratiidae and Serrivomeridae. With the species of these 10 families amounting to only 60% of all, we find that the individual count comes to 98.8% of all the fish taken.

Luminosity is present as follows: in 50% of the orders, 39% of the families, 81% of the genera, 66% of the species and (thanks again to *Cyclothone* and Myctophidae) to 96.5% of all individuals.

The use of a submarine automatically recording pressure gauge has made the exact depths of the long hauls certain. The consistent and long-continued trawls of hundreds of nets at corresponding levels have established a very accurate basis for estimating upper and lower life levels of species, and the level of maximum abundance. Also very sound data have been obtained on relative abundance and rarity. Three examples will suffice. *Cyclothone microdon* and *C. pallida* are very closely related, and yet their totals are 57,512 and 505 respectively; two eels, *Serrivomer beanii* and *S. brevidentatus* are distinguished with difficulty and yet they show the inexplicable difference in numbers of 155 and 7; *Myctophum laternatum* and *M. fibulatum* bear the same extremely close relationship, and they in turn tally at 2,853 and 8 respectively. The value of figures such as these is confirmed by net to net and year to year catches. The *Myctophum* case will illustrate this. The captures during the three years 1929, 1930 and 1931 of *M. laternatum* were 1,047, 877 and 905, while the corresponding years yielded 4, 2 and 2 individuals of *M. fibulatum*.

I have appended a list of the published papers dealing directly with this collection of fish.

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
ALEPOCEPHALIDAE				
Anomalopterus megalops Beebe, 1933	1	1	31	700
Bathytroctes drakei Beebe, 1929	27	1-2	10-22	400-900
Bathytroctes rostratus Günther, 1878	89	1-4	9.5-56	500-1,000
Dolichopteryx binocularis Beebe, 1932	2	1	53-85	200-400
Dolichopteryx longipes (Vaillant), 1888	4	1	23-85	600-800

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Macromastax gymnos Beebe, 1933	1	1	35	1,000
Photostylus pycnopterus Beebe, 1933	1	1	64	800
Xenodermichthys copei (Gill), 1884	3	1	27-34	600-700
BATHYLAGIDAE				
Bathylagus benedicti Goode & Bean, 1895	20	1-2	18-91	400-1,000
Bathylagus glacialis Regan, 1913	99	1-3	24-135	500-1,000
STOMIATIDAE				
Macrostomias calosoma Beebe, 1933	1	1	430	600
Stomias brevibarbatus Ege, 1918	22	1	19-225	400-1,000
Stomias ferox Reinhardt, 1842	96	1-6	23-90	300-1,000
MELANOSTOMIATIDAE				
Bathophilus altipinnis Beebe, 1933	1	1	63	800
Bathophilus brevis Regan & Trewavas, 1930	4	1	13-26	300-900
Bathophilus chironema Regan & Trewavas, 1930	1	1	34	1,000
Bathophilus longipinnis (Pappenheim), 1914	2	1	48-61	400-900
Bathophilus metallicus (Welsh), 1923	22	1-2	25-105	300-900
Bathysphaera intacta Beebe, 1932	2	....	1829	350
Chirostomias pliopterus Regan & Trewavas, 1930 (= *C. lucidimanus* Beebe, 1932).	8	1	19-225	300-700
Echiostoma tanneri (Gill), 1883	13	1	61-375	500-900
Eustomias bibulbosus Parr, 1927	8	1	42-123	500-900
Eustomias bigelowi Welsh, 1923	1	1	108	700
Eustomias fissibarbis (Pappenheim), 1914	1	1	130	800
Eustomias frondosus Regan & Trewavas, 1930	1	1	43	500
Eustomias lipochirus Regan & Trewavas, 1930	1	1	50	500
Eustomias obscurus Vailliant, 1888	5	1	51-98	500-700
Eustomias paucifilis Parr, 1927	1	1	134	800
Eustomias satterleei Beebe, 1933	1	1	140	1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Eustomias schiffi Beebe, 1932	3	1	43-115	600
Eustomias schmidti Regan & Trewavas, 1930	2	1	55-118	700-800
Eustomias simplex Regan & Trewavas, 1930	1	1	91	600
Flagellostomias boureei (Zugmayer), 1913	10	1	7-97	0-1,000
Lamprotoxus angulifer Beebe, 1932	4	1	34-145	400-700
Lamprotoxus flagellibarba Holt & Byrne, 1910	3	1	29-206	500-700
Leptostomias bermudensis Beebe, 1932	1	1	285	500
Leptostomias ramosus Regan & Trewavas, 1930	20	1-2	12-52	50-1,000
Melanostomias bulbosus Beebe, 1933	1	1	222	700
Melanostomias spilorhynchus Regan & Trewavas, 1930	54	1-3	17-240	400-1,000
Pachystomias atlanticus Regan & Trewavas, 1930	1	1	38	500
Photonectes bifilifer Beebe, 1933	1	1	245	800
Photonectes braueri (Zugmayer), 1913	1	1	62	900
Photonectes cornutus Beebe, 1933	1	1	19	600
Photonectes dinema Regan & Trewavas, 1930	26	1-2	24-51	1,000
Photonectes intermedius Parr, 1927	4	1	49-70	400-800
Photonectes leucospilus Regan & Trewavas, 1930	15	1	25-33	300-1,000
Photonectes margarita (Goode & Bean), 1895	6	1	245-300	500-1,000
Photonectes mirabilis Parr, 1927	3	1	18-28	600
Photonectes parvimanus Regan & Trewavas, 1930	10	1	14-44	0-800
MALACOSTEIDAE				
Aristostomias photodactylus Beebe, 1933	1	1	84	700
Aristostomias tittmanni Welsh, 1923	14	1	30-62	500-1,000
Malacosteus niger Ayres, 1849	26	1-2	20-206	500-1,000
Photostomias guernei Collet, 1889	99	1-3	23-145	500-1,000
Ultimostomias mirabilis Beebe, 1933	1	1	40	900
ASTRONESTHIDAE				
Astronesthes gemmifer Goode & Bean, 1895	7	1	21-26	400-700

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Astronesthes niger Richardson, 1845	47	1-2	24-35	300-1,000
Neonesthes nicholsi Beebe, 1933	8	1	26-156	500-1,000
CHAULIODONTIDAE				
Chauliodus danae Regan & Trewavas, 1930	380	1-8	8-113	300-1,000
Chauliodus sloanei Bloch & Schneider, 1801	413	1-9	16-245	300-1,000
GONOSTOMATIDAE				
Bonapartia pedaliota Goode & Bean, 1895	6	1-2	15-55	200-800
Cyclothone microdon (Günther), 1878	57,512	1-268	10-62	300-1,000
Cyclothone braueri Jespersen & Tåning, 1926	37,172	1-471	10-25	100-1,000
Cyclothone pallida Brauer, 1906	505	1-10	20-45	300-1,000
Gonostoma bathyphilum (Vaillant), 1884	5	1	56-165	700-1,000
Gonostoma elongatum Günther, 1878	40	1-2	21-270	400-1,000
Photichthys nonsuchi Beebe, 1932	1	1	89	600
Yarrella blackfordi Goode & Bean, 1895	5	1	16-33	400-1,000
IDIACANTHIDAE				
Idiacanthus fasciola Peters, 1876	129	1-8	16-270	100-1,000
MAUROLICIDAE				
Diplophos taenia Günther, 1873	1	1	35	600
Ichthyococcus ovatus (Cocco), 1838	198	1-5	9.3-31	300-1,000
Maurolicus muelleri (Gmelin), 1789	2	1	7-8	500-800
Valenciennellus tripunctulatus (Lütken), 1870	6	1-2	9-27	100-1,000
Vinciguerria attenuata (Cocco), 1838	219	1-5	7-19	300-1,000
Vinciguerria nimbraria (Jordan & Williams), 1896	4	1-2	14-30	400-800
OPISTHOPROCTIDAE				
Opisthoproctis soleatus Vaillant, 1888	1	1	51	450
STERNOPTYCHIDAE				
Argyropelecus aculeatus Cuvier & Valenciennes, 1849	139	1-12	6-55	300-1,000
Argyropelecus affinis Garman, 1899	2	2	44-48	400

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Argyropelecus hemigymnus Cocco, 1829	295	1-9	5-35	300-1,000
Argyropelecus young (Not yet studied)	691	1-26	6-12	100-1,000
Sternoptyx diaphana Hermann, 1781	1,337	1-9	5-41	0-1,000
HALOSAURIDAE				
Halosaurus sp.	1	1	155	900
ANGUILLIDAE				
Anguilla anguilla (Linnaeus), 1758	26	1-2	20-50	100-1,000
Anguilla rostrata (Le Sueur), 1817	19	1	30-63	500-1,000
SYNAPHOBRANCHIDAE				
Synaphobranchus kaupi Johnson, 1862	11	1-2	63-88	500-900
DERICHTHYIDAE				
Derichthys serpentinus Gill, 1884	18	1	55-268	500-1,000
NESSORHAMPHIDAE				
Nessorhamphus ingolfianus Schmidt, 1930 (Schmidt, 1912)	21	1-2	26-166	400-1,000
SERRIVOMERIDAE				
Serrivomer beanii Gill & Ryder, 1883	155	1-5	55-440	50-1,000
Serrivomer brevidentatus Roule & Bertin, 1929	7	1	73-512	500-800
Platuronides acutus Parr, 1932	22	1	18-178	100-1,000
Platuronides danae Roule & Bertin, 1929	7	1-2	31-488	50-1,000
NEMICHTHYIDAE				
Nemichthys scolopaceus Richardson, 1848	45	1-2	40-360	50-1,000
Avocettina infans Günther, 1876	1	1	498	1,000
Labichthys carinatus Gill & Ryder, 1883	3	1	200-470	500-1,000
CYEMIDAE				
Cyema atrum Günther, 1878	4	1	50-105	800-1,000
EURYPHARYNGIDAE				
Eurpharynx pelecanoides Vaillant, 1882	84	1-3	30-506	500-1,000
SACCOPHARYNGIDAE				
Saccopharynx harrisoni Beebe, 1932	1	1	1,400	900

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
PARALEPIDAE				
Luciosudis sp.	3	1	32-35	500-1,000
Macroparalepis intermedius Ege, 1933	1	1	130	500
Macroparalepis sp.	19	1	8-87	100-900
Paralepis brevirostris (Parr), 1928	60	1-2	8-50	300-1,000
Paralepis brevis Zugmayer, 1911	662	1-7	9-87	300-1,000
Paralepis bronsoni (Parr), 1928	1	1	90	800
Paralepis speciosus? Bellotti, 1877	7	1-2	18-90	500-900
MYCTOPHIDAE				
Diaphus agassizi Gilbert, 1908	2	1	27-34	500-900
Diaphus dofleini Zugmayer, 1911	192	1-12	9-29	300-1,000
Diaphus dumerili (Bleeker), 1856	7	7	54-66	0
Diaphus effulgens (Goode & Bean), 1895	6	1	10-43	500-900
Diaphus fulgens (Brauer), 1904	93	1-9	9-16	300-1,000
Diaphus garmani Gilbert, 1906	1	1	48	0
Diaphus gemellari (Cocco), 1838	27	1-4	10-28	300-1,000
Diaphus hypolucens Parr, 1928	5	1-2	10-12	400-1,000
Diaphus lucidus (Goode & Bean), 1895	4	1	9-11	500-900
Diaphus lutkeni (Brauer), 1904	1	1	42	1,000
Diaphus macrophus Parr, 1928	294	1-14	9-45	300-1,000
Diaphus metopoclampus (Cocco), 1829	13	1	20-80	300-1,000
Diaphus rafinesquei (Cocco), 1820	134	1-9	9-70	400-1,000
Diaphus splendidus (Brauer), 1904	1	1	13	600
Diaphus young (Not yet studied)	122	1-20	8-13	300-1,000
Lampadena anomala Parr, 1928	10	1-3	17-26	500-800
Lampadena bathyphila Tåning, 1928	21	1	17-61	600-1,000
Lampadena braueri Zugmayer, 1914	54	1-3	10-32	300-1,000
Lampadena chavesi (Collet), 1905	9	1	20-27	500-1,000
Lampadena minima Tåning, 1928	5	1	26-40	500-1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Lampanyctus ater Tåning, 1928	23	1-2	7-47	500-1,000
Lampanyctus crocodilus (Risso), 1810	95	1-6	15-32	300-1,000
Lampanyctus cuprarius Tåning, 1928	208	1-6	9-101	50-1,000
Lampanyctus elongatus (Costa), 1844	11	1	13-30	400-1,000
Lampanyctus festivus Tåning, 1928	7	1-2	26-29	500-900
Lampanyctus gaussi (Brauer), 1906	2	1	12-23	400-600
Lampanyctus guntheri Goode & Bean, 1895	42	1-8	16-52	400-1,000
Lampanyctus intricarius Tåning, 1928	1	1	32	700
Lampanyctus lineatus Tåning, 1928	2	1	30-50	600
Lampanyctus longipes (Brauer), 1906	4	1	12-20	800-1,000
Lampanyctus micropterus (Brauer), 1906	2	1	19-21	500
Lampanyctus niger (Günther), 1887	1	1	37	900
Lampanyctus nobilis Tåning, 1928	3	1-2	14-22	800-1,000
Lampanyctus photonotus Parr, 1928	1	1	14	500
Lampanyctus polyphotis Beebe, 1932	60	1-5	7-67	400-1,000
Lampanyctus photothorax Parr, 1928	891	1-20	9-37	300-1,000
Lampanyctus pusillus (Johnson), 1890	942	1-13	10-38	300-1,000
Lampanyctus resplendens Richardson, 1844-1848	14	1	23-37	600-1,000
Lampanyctus septilucis Beebe, 1932	3	1-2	28-31	700
Lampanyctus subpectoralis Parr, 1928	153	1-11	14-39	200-1,000
Lampanyctus supralateralis Parr, 1928	27	1-4	13-27	400-1,000
Lampanyctus taaningi Parr, 1929	350	1-7	13-58	500-1,000
Lampanyctus warmingi (Lütken), 1892	880	1-47	9-40	400-1,000
Myctophum affine (Lütken), 1892	37	1-2	13-25	400-1,000
Myctophum benoiti (Cocco), 1838	1,294	1-67	5-40	300-1,000
Myctophum coccoi (Cocco), 1829	165	1-3	7-26	300-1,000
Myctophum fibulatum Gilbert & Cramer, 1897	8	1-2	12-25	400-900

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Myctophum glaciale (Reinhardt), 1837	2	1	26-28	700-900
Myctophum humboldti (Risso), 1810	2	2	21	1,000
Myctophum hygomi (Lütken), 1892	131	1-7	11-38	300-1,000
Myctophum imitator Parr, 1928	30	1-3	10-22	400-1,000
Myctophum laternatum Garman, 1899	2,853	1-43	9-22	100-1,000
Myctophum macrochir (Günther), 1864	170	1-5	10-44	300-1,000
Myctophum nigro-ocellatum (Günther), 1889	13	1-2	11-19	500-600
Myctophum rarum (Lütken), 1892	10	1	21-26	500-1,000
Myctophum reinhardti (Lütken), 1892	72	1-4	11-35	100-1,000
Myctophum rufinum Tåning, 1928	6	1	20-28	600-700
Myctophum valdiviae Brauer, 1904	846	1-44	9-23	300-1,000
Myctophid young (Not yet studied)	1,646	1-67	7-16	0-1,000
SCOPELARCHIDAE				
Scopelarchus anale (Brauer), 1902	14	1	18-130	500-1,000
EVERMANNELLIDAE				
Evermannella atlantica Parr, 1928	1	1	35	500
Evermannella balbo (Risso), 1820	8	1	20-39	400-900
Evermannella melanoderma Parr, 1928	38	1	17-31	300-1,000
OMOSUDIDAE				
Omosudis lowii Günther, 1887	134	1-3	5-180	400-1,000
ALEPISAURIDAE				
Alepisaurus ferox Lowe, 1833	122	1-4	7-190	500-1,000
RONDELETIIDAE				
Rondeletia bicolor Goode & Bean, 1895	2	1	97	600-1,000
CETOMIMIDAE				
Genera & spp.	11	1-2	30-105	700-1,000
Bathyembryx istiophasma Beebe, 1934	1	....	600	416
MACRURIDAE				
Macrurus spp.	5	1	64-68	500-1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
BREGMACEROTIDAE				
Bregmaceros atlanticus Goode & Bean, 1895	35	1-2	9-75	400-1,000
GADIDAE				
Laemonema barbatula Goode & Bean, 1883	1	1	72	900
Melanonus unipinnis Beebe, 1932	50	1-2	9-75	400-1,000
Physiculus kaupi Poey, 1865	1	1	35	100
MELAMPHAEIDAE				
Anoplogaster cornutus (Cuvier & Valenciennes), 1833	22	1-2	4-48	25-1,000
Caulolepis longidens Gill, 1883	7	1	90-151	700,-1,000
Melamphaes cristiceps Gilbert, 1891	61	1	17-105	500-1,000
Melamphaes megalops Lütken, 1877	1	1	41	700
Melamphaes microps (Günther), 1878	989	1-18	9-36	300-1,000
Melamphaes mizolepis (Günther), 1878	65	1-2	8-56	300-1,000
Melamphaes nigrofulvus Garman, 1899	1	1	93	700
Melamphaes robustus Günther, 1887	306	1-4	13-42	100-1,000
Melamphaes typhlops (Lowe), 1843	5	1	13-52	400-1,000
Melamphaes young	600	1-14	6-13	300-1,000
TRICHIURIDAE				
Benthedesmus atlanticus Goode & Bean, 1895	2	2	200-205	In stomach of *Parathunnus atlanticus*
ACROPOMATIDAE				
Oxyodon sp.	51	1-4	9-40	400-1,000
CHIASMODONTIDAE				
Chiasmodon spp.	27	1	8-220	500-1,000
Odontonema sp.	1	1	85	900
Pseudoscopelus stellatus Beebe, 1932	8	1-2	14-45	25-1,000
BROTULIDAE				
Brotula spp.	8	1	7-50	700-900
Parabrotula dentiens Beebe, 1932	1	1	28	800
Parabrotula sp.	3	1	30-31	700-1,000
Mixonus laticeps (Günther), 1878	1	1	43	700
LOPHIIDAE				
Lophius sp.	1	1	14	1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
OGCOCEPHALIDAE				
Dibranchus sp.	4	1	25-28	600
LINOPHRYNIDAE				
Linophryne arborifera Regan, 1925	5	1	1.3-31	600-800
Linophryne brevibarbata Beebe, 1932	2	1	26-33	700-900
Edriolychnus sp.	2	1	23-30	900
Haplophryne spp.	3	1	11-18	700-1,000
ONEIRODIDAE				
Chaenophryne crossotus Beebe, 1932	1	1	17	500
Chaenophryne draco Beebe, 1932	1	1	18	600
Chaenophryne longiceps Regan, 1925	1	1	42	1,000
Dolopichthys analogus Parr, 1927	2	1	17	500-600
Dolopichthys gladisfenae Beebe, 1932	1	1	40	700
Dolopichthys longicornis Parr, 1927	2	1	27-42	900-1,000
Dolopichthys tentaculatus Beebe, 1932	3	1	14-17	600-900
Lasiognathus beebei Regan & Trewavas, 1932	1	1	38	600
Lophodolus acanthognathus Regan, 1925 (= *L. lyrae* Beebe, 1932)	45	1	10-47	600-1,000
MELANOCETIDAE				
Melanocetus spp.	12	1	9-86	0-1,000
CERATIIDAE				
Bathyceratias trilychnus Beebe, 1934	1	....	152	411
Cryptosparas cousii Gill, 1883	24	1	10-28	0-1,000
Mancalias uranoscopus Murray, 1878	1	1	17.5	900
ACERATIIDAE				
Aceratias edentula Beebe, 1932	1	1	19.6	1,000
Aceratias spp.	91	1-3	3-19	500-1,000
Rhynchoceratias spp.	128	1-2	8-36	25-1,000
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Bathysidus pentagrammus Beebe, 1934	1	....	152	316

Bibliography.

Beebe, W.

1931a Bermuda Oceanographic Expeditions 1929-1930. Introduction. *Zoo·* Vol. XIII, No. 1.

1931b Bermuda Oceanographic Expeditions 1929-1930. List of Nets and Data. *Zoologica*, Vol. XIII, No. 2.

1932a Bermuda Oceanographic Expeditions 1931. Individual Nets and Data *Zoologica*, Vol. XIII, No. 3.

1932b Nineteen New Species and Four Post-larval Deep-sea Fish. *Zoologica*, Vol. XIII, No. 4.

1932c Ontological Notes on *Remora remora*. *Zoologica*, Vol. XIII, No. 6.

1932d A New Deep-sea Fish. *Bull. N. Y. Zool. Soc.*, Vol. XXXV, No. 5, pp. 175-177.

1933a Preliminary Account of Deep Sea Dives in the Bathysphere with Especial Reference to One of 2200 Feet. *Proc. Nat. Acad. Sci.*, Vol. XIX, No. 1, pp. 178-188.

1933b Rapport Préliminaire sur les Explorations de Mer Profonde, dans la Bathysphère, avec Référence Speciale à Celle de 660 Mètres. (Traduit par C. Vallaux). *Bull. de l'Institut Océanographique*, Monaco, No. 629.

1933c Deep-sea Isospondylous Fishes: Two New Genera and Four New Species. *Zoologica*, Vol. XIII, No. 8.

1933d Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Introduction. *Zoologica*, Vol. XVI, No. 1.

1933e Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Alepocephalidae. *Zoologica*, Vol. XVI, No. 2.

1933f Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Argentinidae. *Zoologica*, Vol. XVI, No. 3.

1933g Deep-sea Stomiatoid Fishes: One New Genus and Eight New Species. *Copeia*, 1933, No. 4, pp. 160-175.

1934a Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Idiacanthidae. *Zoologica*, Vol. XIV, No. 4.

1934b Oceanographic Work at Bermuda of the New York Zoological Society. *Science*, Vol. LXXX, No. 2083, pp. 495-496.

1934c Three New Deep-sea Fish Seen from the Bathysphere. *Bull. N. Y. Zool. Soc.*, Vol. XXXVII, No. 6, pp. 190-193.

1934d Summary and Conclusions concerning Bathysphere Observations. Appendix H in "Half Mile Down." Harcourt Brace & Co.

1935a Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Derichthyidae. *Zoologica*, Vol. XX, No. 1.

1935b Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Nessorhamphidae. *Zoologica*, Vol. XX, No. 2.

1936a Bermuda Oceanographic Expeditions. Individual Nets and Data, 1932-1935. *Zoologica*, Vol. XXI, No. 3.

1936b Food of the Bermuda and West Indian Tunas of the Genera *Parathunnus* and *Neothunnus*. *Zoologica*, Vol. XXI, No. 15.

Beebe, W., & Crane, J.

1934 Classified Résumé of Organisms Observed from the Bathysphere. Appendix G in "Half Mile Down" by William Beebe. Harcourt, Brace and Co.

1936 Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Serrivomeridae. Part I: Genus *Serrivomer*. *Zoologica*, Vol. XX, No. 3.

1937 Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Serrivomeridae. Part II: Genus *Platuronides*. *Zoologica*.

1937 Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Nemichthyidae. *Zoologica*.

Beebe W., & Tee-van, J.

1936 Systematic Notes on Bermudian and West Indian Tunas of the Genera *Parathunnus* and *Neothunnus*. *Zoologica*, Vol. XXI, No. 14.

Goldschmidt, R.

1933 A Note on *Amphioxides* from Bermuda Based on Dr. W. Beebe's Collection. *Biological Bull.*, Vol. LXIV, No. 3, pp. 321-325.

15.

The Templeton Crocker Expedition. X. Echinoderms from the West Coast of Lower California, the Gulf of California and Clarion Island[1].

FRED C. ZIESENHENNE

Virginia Barret Gibbs Scholar, 1936-37,
Museum of Comparative Zoölogy, Cambridge, Massachusetts.

(Text-figures 1 & 2).

[Note: This is the tenth of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica,* No. 2, pp. 33 to 46.]

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[1] Contribution No. 529, Department of Tropical Research, New York Zoological Society.

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Introduction.

The collection of echinoderms made by the Templeton Crocker Expedition of the New York Zoological Society on the yacht *Zaca* to the Gulf of California and adjacent waters in the spring of 1936 is of great interest. With the exception of *Ophiura lütkeni*, of which there are 1,844 specimens, the collection is rich in quality but not in quantity. It consists of 2,277 specimens representing 65 species, viz., 27 sea-stars, 21 ophiurans, 16 echini and 1 crinoid[2]. There are two new brittle-stars which are described in this report. No fewer than 28 species are represented by only one or two specimens and some of these species have not been taken previously since they were described more than 20 years ago. A number of specimens were badly crushed and in poor condition; only one sea-star, however, was unidentifiable.

The region explored is on the boundary between the Panamic fauna and the North Pacific fauna; however, 31 species have been previously taken in the Panamic region, 22 species are of the North Pacific fauna, while 12 species are confined to the Gulf of California. It is interesting that several species were taken that had not been recorded since Verrill described them in 1871. The farther south one collects it becomes more and more evident that the North Pacific littoral species occur only in the deeper water; most of the material was taken at depths of less than 100 fathoms. The richest littoral stations were Santa Inez Bay in the Gulf of California, and Sulphur Bay, Clarion Island. Of the new brittle-stars one belongs to the large genus *Ophiacantha*, while the other is a representative of the genus *Ophiuroconis*.

I wish to express my indebtedness to Dr. William Beebe for the opportunity of studying this interesting material. Thanks are also due to Dr. H. L. Clark and Dr. E. Deichmann for their invaluable help in working up the material, and to Dr. W. K. Fisher for his expert assistance in determining some of the difficult sea-stars. Dr. Deichmann and Dr. Fenner A. Chace, Jr., have generously read the proofs.

The field color notes were made by members of the expedition.

The specimens are all deposited in the collections of the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

[2] The holothurians taken have been discussed by Dr. E. Deichmann in the present volume of *Zoologica*, pp. 161 to 176.

CLASS CRINOIDEA.

Family Antedonidae.

Florometra perplexa (A. H. Clark).

Antedon perplexa A. H. Clark, 1907, p. 74.

Florometra perplexa, A. H. Clark, 1921, p. 60, pl. 62, figs. 95, 96; pl. 5, figs. 1009-1014.

Type: Cat. No. 22611, U. S. N. M.

Type Locality: Off the coast of Washington, *Albatross* Station No. 3070.

General Range: From Alaska and Monterey Bay to the Gulf of Panama and the Galápagos Islands. From 45 to 581 fathoms.

Local Distribution: One adult from west of San José Point, Lower California (Station 175:D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: This interesting crinoid is the only one in the collection. It is a good-sized specimen and the color in life was reddish-brown, pinnules dark brown to black, cirri light brown. Length of arms 111 mm., longest cirrus 33 mm.

CLASS ASTEROIDEA.

Family Astropectinidae.

Astropecten armatus Gray.

Astropecten armatus Gray, 1840, p. 181.

Astropecten armatus, Fisher, 1911, p. 56.

Type: British Museum.

Type Locality: Puerto Portrero, South America (Gray).

General Range: From San Pedro, California, to Punta Santa Elena, Ecuador. From shore to 80 fathoms.

Local Distribution: A total of 21 specimens was taken from Magdalena Bay, Gorda Banks, Arena Bank, the Inez area and Clarion Island between three feet and 80 fathoms on muddy, sandy and rocky bottoms.

Remarks: This series is composed mainly of young specimens ranging in size from R = 5 mm. to R. = 146 mm.; the ratio between arms and disk radius rises from R = 2.5 r to R = 5.5 r. The supero-marginal spines are developed even in the smallest individuals. The color in life was usually pink, sometimes scarlet. The color of the dried specimens ranges from pale green to light brown, with the small ones cream color.

Material: Magdalena Bay: (2 young). Station 136: D-1 (3 young). Station 142: D-1 (1 adult). Station 143: D-1 (3 young), D-3 (5 young). Station 145: D-1 (1 adult). Station 150: D-9 (1 young), D-13 (2 young), D-16 (2 young). Station 163: D-3 (1 young).

Astropecten californicus Fisher.

Astropecten californicus Fisher, 1906, p. 299.

Astropecten californicus, Fisher, 1911, p. 61.

Type: No. 157, Stanford University Invertebrate Collection.

Type Locality: Monterey Bay, California; 70 fathoms.

General Range: From north of Bodega Head, California, to Lower California, Mexico. From 10 to 244 fathoms.

Local Distribution: A total of five specimens was taken off San José Point, Lower California, from east of Cedros Island and on Gorda Banks between 38 and 70 fathoms on muddy and shaley bottoms.

Remarks: This series is composed entirely of young individuals, ranging from R = 13 mm. to R = 22 mm. The color of the dried specimens is brown in diverse shades; color in life pinkish.

Material: Station 126: D-1 (1 young). Station 150: D-4 (1 young) Station 175: D-1 (3 young).

Thrissacanthias penicillatus (Fisher).

Persephonaster penicillatus Fisher, 1905, p. 297.

Thrissacanthias penicillatus, Fisher, 1911, p. 79.

Type: Cat. No. 22329, U. S. N. M.

Type Locality: Off Los Coronados Islands, southwest of San Diego, California. From 530 to 638 fathoms.

General Range: From Washington to Lower California. From 30 to 822 fathoms.

Local Distribution: One young individual was taken in Santa Inez Bay (Station 142: D-2) at a depth of 30 to 35 fathoms on a bottom composed of mud and crushed shell.

Remarks: Although no young specimen in the M. C. Z. collection is as small as the *Zaca* specimen, comparison shows that this individual is probably the young of *T. penicillatus,* but it is the first specimen recorded from the Gulf of California, and the first from a depth of less than 277 fathoms. R = 6 mm.; r = 2 mm. The color (dried) is light brown with lighter rays.

Sideriaster canaliculata A. H. Clark.

Sideriaster canaliculata A. H. Clark, 1916, p. 52.

Type: Cat. No. 36951, U. S. N. M.

Type Locality: Gulf of California, 40 fathoms, *Albatross* Station 2998.

General Range: Gulf of California, Santa Inez Bay to Arena Bank. From 35 to 60 fathoms.

Local Distribution: A total of 12 specimens was taken from Gorda Banks, Arena Bank and the Inez area between 35 and 60 fathoms on muddy bottoms.

Remarks: These are the first specimens to be collected since the species was described in 1916. The series is interesting because of the diversity in size, ranging from R = 4 mm. to R = 87 mm. In the smallest specimen, R = 2 r but as growth proceeds, R increases disproportionately until in the largest it considerably exceeds 3 r. A. H. Clark's type has R = 64 mm. and r = 19. The color of the larger dried specimens at hand is brownish-white, the color in life was pinkish to coral red.

Material: Station 136: D-14 (1 young). Station 142: D-3 (2 adults, 2 young). Station 146: D-1 (1 young). Station 147: D-2 (1 young, tip of an adult ray). Station 150: D-9 (5 young).

Family Luidiidae.

Luidia bellonae Lütken.

Luidia bellonae Lütken, 1865, p. 133.

Luidia bellonae, H. L. Clark, 1910, p. 330.

Type: Probably in Copenhagen.

Type Locality: Guayaquil, Ecuador.

General Range: Gulf of California to Iquiqui, Chile, and the Galápagos Islands. From 2 to 30 fathoms.

Local Distribution: A total of 4 specimens was taken from Santa Inez Bay, Station 142: D-1 (1 adult), and Station 143: D-1 (3 young), between 29 and 30 fathoms on muddy bottoms.

Remarks: This series was in very poor condition, probably being broken in the dredge. Largest specimen R = 115 mm.; r = 13 mm. The smaller specimens were in too poor condition to permit measurement. The color of the large specimen was lavender in life, and, dried, it is gray with dark cross-bands on the arms. The dorsal spines are light gray; the longest are 4 mm. in length; marginal spines about 5 mm. long, gray at base with white tips.

Luidia columbia (Gray).

Petalaster columbia Gray, 1840, p. 183.

Luidia columbia, Sladen, 1889, p. 247. H. L. Clark, 1910, p. 331.

Type: British Museum.

Type Locality: "St. Blas," probably the west coast of Mexico.

General Range: From Magdalena Bay and the Gulf of California to northern Peru and the Galápagos Islands. From two to 80 fathoms.

Local Distribution: A total of 15 specimens was taken from east of Cedros Island, from Gorda Banks, Arena Bank, Santa Inez Bay and Clarion Island, between two and 80 fathoms on muddy, sandy and hard bottoms and in coral (*Pocillopora ligulata*).

Remarks: This series ranges in size from R = 8 mm. to R = 213 mm. The color of the dried specimens is brown of diverse shades, with white spines and oral surface. Several specimens have white and brown irregular markings on the disk and arms. The color in life was coral pink with orange spines.

Material: Station 126: D-3 (1 adult). Station 127: D-1 (tip of ray). Station 136: D-1 (1 adult), D-33 (1 adult). Station 142: D-3 (2 young). Station 143: D-3 (3 young). Station 147: D-2 (1 adult, 3 young). Station 150: D-13 (1 adult), D-16 (1 adult). Station 163: D-3 (1 adult).

Luidia foliolata Grube.

Luidia foliolata Grube, 1866, p. 59.

Luidia foliolata, Fisher, 1911, p. 106.

Type: Unknown.

Type Locality: Unknown.

General Range: From southeast Alaska (Kasaan Bay) to San Diego, California, and probably to Mazatlan. From 10 to 189 fathoms, usually less than 80 fathoms.

Local Distribution: Three specimens were taken west of San José Point, Station 175: D-1 (1 adult, 2 young), at a depth of 45 fathoms.

Remarks: These specimens are well preserved and in good condition. Size ranges from R = 15 mm.; r = 4 mm. to R = 91 mm.; r = 8 mm. The color of the dried specimens is brown with white spots irregularly scattered on the disk and arms; bordering the marginal plates are rows of white paxillae; oral surface dirty yellow.

The known range is extended to Lower California by this record which is the farthest south the species has been taken.

Luidia phragma H. L. Clark.

Luidia phragma H. L. Clark, 1910, p. 329.

Type: No. 398, M. C. Z.

Type Locality: Probably Peru.

General Range: Gulf of California to Peru. From three feet to 30 fathoms.

Local Distribution: A total of four specimens was taken on the shore of Magdalena Bay and in Santa Inez Bay at three feet and 13 fathoms.

Remarks: Of this colorful species the smallest specimen has R = 35 mm., the largest R = 45 mm. The third row of paxillae from the marginal plates bears spines. The color of the dried specimens is gray, with each arm having a brown stripe down the center; the margins have black bars, one in each inter-radius and 3 to 4 on the arms, but in one specimen these bars are not so distinct. The oral side and lateral spines are white.

Material: Magdalena Bay: (1 adult). Station 145: D-1 (3 adults).

Family Odontasteridae.

Odontaster crassus Fisher.

Odontaster crassus Fisher, 1904, p. 302.

Odontaster crassus, Fisher, 1911, p. 156.

Type: Cat. No. 22333, U. S. N. M.

Type Locality: Albatross Station 4313, vicinity of San Diego. From 92 to 243 fathoms.

General Range: Monterey Bay to San Diego, and northern Lower California. From 43 to 243 fathoms.

Local Distribution: One young specimen was taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: The specimen has R = 12 mm. The color (dried) is cream on the marginal plates and oral side; the paxillar area is light brown.

The known range is extended about 100 miles to the south by this record.

Family Goniasteridae.

Mediaster aequalis Stimpson.

Mediaster aequalis Stimpson, 1857, p. 530, pl. 23, figs. 7-11.

Mediaster aequalis, Fisher, 1911, p. 198.

Type: Cat. No. 1977, U. S. N. M.

Type Locality: Puget Sound, Washington, or San Francisco.

General Range: From the Alaska Peninsula (Chignik Bay) to northern Lower California. From 9 to 160 fathoms.

Local Distribution: A total of four specimens was taken west of San José Point, Lower California (Station 175: D-1, 2 young; D-3, 2 adults) at a depth of 45 fathoms on shaley bottom.

Remarks: The smallest specimen R = 7 mm., largest R = 38 mm. Color (dried) is a dirty cream; the madreporite is light buff; color of adults in life, bright red.

Amphiaster insignis Verrill.

Amphiaster insignis Verrill, 1868, p. 372.

Type: Cat. No. 581, M. C. Z. (cotype).

Type Locality: La Paz, Lower California.

General Range: Magdalena Bay and Gulf of California. From 30 to 45 fathoms.

Local Distribution: A total of 18 specimens was taken from Arena Bank and Santa Inez Bay between 18 and 45 fathoms on sandy and muddy bottoms.

Remarks: In the smallest specimen R = 9 mm.; in the largest R = 59 mm. The color (dried) is a light dirty brown; the color in life was pale pink to carrot red.

Material: Station 136: D-1 (1 young, 6 adults), D-2 (1 young), D-13 (1 adult), D-26 (2 young, 1 adult). Station 141: D-3 (3 adults). Station 142: D-1 (2 young). Station 143: D-1 (1 adult).

Family Oreasteridae.

Pauliella aenigma Ludwig.

Pauliella aenigma Ludwig, 1905, p. 151.

Type: Cat. No. 2403, M. C. Z. (cotype).

Type Locality: Cocos Island, off Costa Rica, *Albatross* Station 3368.

General Range: Cocos and Clarion Islands. From 45 to 67 fathoms.

Local Distribution: One specimen was taken off Clarion Island (Station 163: D-2) at a depth of 55 fathoms on a rocky bottom with coral.

Remarks: This specimen has R = 16.5 mm. and r = 11.5 mm.; a cotype in the M. C. Z. has R = 13.5 mm., r = 9.5 mm.; a large specimen with R = 16.5 mm. and r = 12 mm. was described by Ludwig and it agrees well with the present individual, especially in the ambulacral armature. The cotype and this individual differ from each other chiefly in the size of the dorsal and lateral spines. In the cotype the central dorsal spines, 5 in number (3 broken), are 1 mm. high, while the distal dorsal spines, arranged in 5 groups of 12 to 15, are 8 mm. high. The *Zaca* specimen has no central spines but 11 spheroidal naked plates surrounded at their base with series of granules. The distal dorsal spines are small and few, none exceeding 3 mm. in length. The inter-radial, intra-marginal spines are well developed in the cotype, where there are ten, conical and blunt, the longest 1 mm. in length. In the present specimen the intra-marginal spines are small and the area between the dorsal and ventral marginal plates is greatly reduced. These differences however are probably due to growth changes. With advancing age it may be that the spines are lost and the enlarged plates occupy their place.

The color (dried) is creamish-white both above and below; the triangular madreporite is light brown; each inter-radius dorsally has a light yellow area.

This is the first specimen of *Pauliella* to be recorded since the types were taken by the *Albatross* at Cocos Island in 1891. The known range is now extended to Clarion Island about 2,100 miles to the northwest.

Oreaster occidentalis Verrill.

Oreaster occidentalis Verrill, 1867a, p. 278.

Oreaster occidentalis, H. L. Clark, 1910, p. 333.

Type: Probably in Peabody Museum, New Haven.

Type Locality: West coast of Panama.

General Distribution: Gulf of California to northern Peru and the Galápagos Islands. From three to 40 fathoms.

Local Distribution: A total of three specimens was taken from Arena Bank and Santa Inez Bay between five and 45 fathoms on sandy and muddy bottoms.

Remarks: All the specimens at hand of this common species are small with R ranging from 47 to 91 mm. Their color in life ranged from orange to red; dried from alcohol it is brown with a reddish tinge; papular areas gray in both living and dried specimens.

Material: Station 136: D-6 (1 adult), D-23 (1 young). Station 141: D-1 (1 adult).

Nidorellia armata (Gray).

Pentaceros armatus Gray, 1840, p. 277.

Nidorellia armata, Verrill, 1867a, p. 280; H. L. Clark, 1910, p. 332.

Type: Probably in the British Museum.

Type Locality: Punta Santa Elena, Ecuador. From 12 to 15 fathoms.

General Range: From Guaymas, Mexico, to Zorritos, Peru, and the Galápagos Islands. From shore to 40 fathoms.

Local Distribution: A total of three specimens was taken off Arena Bank and off Santo Domingo Point, Santa Inez Bay, between one and 2½ fathoms in coral (*Pocillopora ligulata*) and on a sandy bottom.

Remarks: In the smallest specimen R = 55 mm., in the largest R = 72 mm. The color in life was olive with dark blue spines. The armature varies greatly; there are 33 short, blunt, dorsal spines on the smallest specimen, and two to four blunt marginal spines at ray tips; in the largest specimen there are 104 short pointed dorsal spines, and marginal spines on all but four superomarginal plates. The intermediate specimen has 16 long, blunt, dorsal spines 10 mm. high; superomarginal spines near tip of ray, about four on each side 6 mm. long.

Material: Station 136: D-33 (1 adult). Near Station 145: (2 adults).

Family Ophidiasteridae.

Linckia columbiae Gray.

Linckia columbiae Gray, 1840, p. 285.

Linckia columbiae, Fisher, 1911, p. 242.

Type: Probably in the British Museum.

Type Locality: "West coast of Colombia" (Gray).

General Range: San Pedro, California, to Colombia and the Galápagos Islands. From shore to 55 fathoms.

Local Distribution: A total of three specimens was taken from Arena Bank and off Clarion Island between 45 and 55 fathoms on muddy and rocky bottoms.

Remarks: The largest specimen has R = 55 mm., the smallest 51 mm. All have five arms, but one has two arms, 12 and 21 mm. in length, in process of regeneration. Color of the dried specimens light tan.

Material: Station 136: D-1 (2 adults). Station 163: D-2 (1 adult).

Narcissia gracilis A. H. Clark.

Narcissia gracilis A. H. Clark, 1916, p. 58.

Type: Cat. No. 38,317, U. S. N. M.

Type Locality: Albatross Station 2829, off Lower California, 31 fathoms.

General Range: Gulf of California. From 31 to 50 fathoms.

Local Distribution: A total of nine specimens was taken from Arena Bank and Gorda Banks between 45 and 50 fathoms on muddy and sandy bottoms.

Remarks: The specimens at hand are all young (R = 13 to 34 mm.) and are more depressed than the adults, which have the arms decidedly triangular in cross-section. The species is rare, only a few having been taken since the type was described in 1916. The color of the living specimens ranged from coral pink to burnt orange; dried, they are yellowish-brown.

Material: Station 136: D-1 (1 young), D-13 (1 young), D-23 (2 young), D-26 (4 young). Station 150: D-10 (1 young).

Phataria unifascialis (Gray).

Linckia unifascialis Gray, 1840, p. 285.

Phataria unifascialis, Sladen, 1889, p. 786; H. L. Clark, 1910, p. 335.

Type: Probably in the British Museum.

Type Locality: Bay of Caracas, west coast of Colombia.

General Range: From the Gulf of California to Zorritos, Peru. From shore to 10 fathoms.

Local Distribution: Two adults were taken from Arena Bank (Station 136: D-33) at a depth of two fathoms in coral (*Pocillopora ligulata*).

Remarks: This tropical species is abundant on rocky shores in the Panamic region and can easily be collected at low tide. The larger specimen in the *Zaca* collection has R = 58 mm., while in the smaller R = 45 mm.; both specimens show evidence of regeneration, so that neither is quite typical, the rays being short and heavy. The dried specimens are a bleached dirty cream color.

Pharia pyramidata (Gray).

Ophidiaster pyramidatus Gray, 1840, p. 284.

Pharia pyramidata, Sladen, 1889, p. 784; H. L. Clark, 1910, p. 335.

Type: Probably in the British Museum.

Type Locality: Bay of Caracas, west coast of Colombia, on rocks.

General Range: From the Gulf of California to Punta Santa Elena, Ecuador; Zorritos, Peru, and the Galápagos Islands. From shore to 10 fathoms.

Local Distribution: One adult was taken from Arena Bank (Station 136: D-33) at a depth of two fathoms in coral (*Pocillopora ligulata*).

Remarks: The specimen has R = 66 mm., and the color is brown with faded yellow papular areas.

Leiaster teres (Verrill).

Lepidaster teres Verrill, 1871a, p. 578.

Leiaster teres, Sladen, 1889, p. 408.

Type: Probably in the Peabody Museum, New Haven.

Type Locality: La Paz, Lower California.

General Range: Confined to the Gulf of California. From 20 to 30 fathoms.

Local Distribution: One adult specimen was taken from Gorda Banks (Station 150: D-7) between 20 and 30 fathoms on a muddy bottom.

Remarks: This specimen is the first one to be collected since Verrill's type was taken by Captain J. Pedersen near La Paz. Verrill says the type was "pale yellow" when dried; probably in had been in alcohol for some time. The present specimen in life was brilliant cerise pink; at present it has faded to a dull rose. In his "Echinoderms of Torres Strait" (1921, p. 73) H. L. Clark refers to Verrill's ambiguity about the papular arrangement, but the specimen now at hand shows clearly that the papulae are grouped, thus leaving no doubt that it is a true *Leiaster*. The *Zaca* specimen has R = 44 mm., about the same as in the type.

Family Echinasteridae.

Henricia asthenactis Fisher.

Henricia asthenactis Fisher, 1910, p. 572.
Henricia asthenactis, Fisher, 1911, p. 297.

Type: Cat. No. 27,782, U. S. N. M.

Type Locality: Albatross Station 4423 between Santa Barbara and San Nicholas Islands, California. From 216 to 339 fathoms.

General Range: Vicinity of Santa Barbara Islands, Shumagin Islands, Bering Sea (Bowers Bank and off Kamchatka), and the Gulf of California. From 67 to 682 fathoms.

Local Distribution: A total of three specimens was taken from Gorda Banks between 50 and 75 fathoms on muddy and hard bottoms.

Remarks: These specimens extend the range of the species over a thousand miles to the south. The adult differs slightly from the northern form, but since the species of this genus vary greatly, it does not seem desirable to make it a named variety. It has R = 17 mm., and the color in life was pinkish; dried it is cream with light brown papular areas. The two young specimens are six-armed, one regenerating three arms (R = 11 mm., other arms R = 19 mm.) and the other has two arms (R = 15 mm. and four buds with R = 5 mm.) The color is the same as in the adult.

Material: Station 150: D-9 (2 young), D-16 (1 adult).

Henricia aspera Fisher.

Henricia aspera Fisher, 1906, p. 127.
Henricia aspera, Fisher, 1911, p. 393.

Type: Cat. No. 21,930, U. S. N. M.

Type Locality: Albatross Station 3052, Heceta Bank, Oregon, 48 fathoms.

General Range: From Bering Sea (Bering and Pribilof Islands), south to San José Point, Lower California. From 26 to 313 fathoms.

Local Distribution: One specimen was taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: This specimen has R = 34 mm. It extends the known range of the species about 200 miles to the south.

Henricia leviuscula dyscrita Fisher.

Henricia leviuscula dyscrita Fisher, 1911, p. 298.

Type: Cat. No. 27,780, U. S. N. M.

Type Locality: Albatross Station 2907, near Point Conception, California, at 44 fathoms.

General Range: Middle California to Cedros Island. From off shore to about 80 fathoms.

Local Distribution: A total of five specimens was taken west of San José Point, and east of Cedros Island at 45 and 60 fathoms on bottoms of shale and crushed shell.

Remarks: The smallest has R = 23 mm., in the largest it is 37 mm. This material extends the known range about 300 miles southward. The color of the adult in life was buffy-yellow.

Material: Station 126: D-10 (1 adult). Station 175: D-2 (4 young).

Henricia polyacantha Fisher.

Henricia polyacantha Fisher, 1906, p. 129.
Henricia polyacantha, Fisher, 1911, p. 302.

Type: Cat. No. 21,932, U. S. N. M.

Type Locality: Albatross Station 2936, off San Diego, California, at 359 fathoms.

General Range: San Diego, California, to the Gulf of California. From 70 to 359 fathoms.

Local Distribution: One adult was taken from Gorda Banks (Station 150: D-13) at a depth of 70 to 80 fathoms on a rough bottom.

Remarks: The known range of *H. polyacantha* is extended about 100 miles to the south by this specimen which was pinkish in life, is pale cream color dried, and has R = 56 mm. This specimen is a southern variety but not distinctive enough to be named as a subspecies.

Echinaster tenuispinus Verrill.

Echinaster tenuispinus Verrill, 1871a, p. 577.
Echinaster tenuispinus, H. L. Clark, 1913, p. 195.

Type: Probably in Peabody Museum, New Haven.

Type Locality: La Paz, Lower California.

General Range: Confined to the Gulf of California. From shore to 10 fathoms.

Local Distribution: Two young specimens were taken from Santa Inez Bay (Station 144: D-2) at a depth of 2½ fathoms, and one adult from the tidal zone of the same bay. The bottom in both cases was sandy.

Remarks: In the smallest specimen R = 4 mm., while in the largest R = 42 mm. The color of the dried specimen is brown with only the spine tips light; orally the ambulacra are pale yellow with light-colored spines.

Family Acanthasteridae.

Acanthaster ellisii (Gray).

Echinaster ellisii Gray, 1840, p. 281.
Acanthaster ellisii, Verrill, 1869, p. 385.

Type: Probably in the British Museum.

Type Locality: South America?; H. Cuming, Esq., (Gray).

General Range: Gulf of California, Galápagos Islands and Clarion Island. From shore to 6 fathoms.

Local Distribution: One adult was taken from Sulphur Bay, Clarion Island, between one and 6 fathoms on a bottom formed of coral and rock.

Remarks: This seems to be a rare species, since less than a dozen specimens have been recorded. W. P. Sladen (*Rep. Voy. Challenger,* vol. 30, 1889, p. 536) doubts the validity of the species but later collectors have added specimens from other localities and it is now generally accepted.

One specimen when lifted into a boat was said to inflict a painful sting. Other specimens have been handled by the present writer without any stinging or other unusual sensations. It may be that a coelenterate had become accidentally enmeshed on the numerous spines of the sea-star and caused the stinging sensation reported. But it is possible that *Acanthaster* may possess poisonous pedicellariae as many sea urchins do. When more living specimens are taken, experiments should be carried out to determine the effect and source of the stinging, if any occurs.

The present specimen in life showed dorsally three concentric rings of rufous, apricot buff and rufous around a center of the apricot buff shades; spines dove gray basally, vinaceous pink distally; oral surface vinaceous pink; tube-feet greenish yellow; dorsal surface of rays dove gray, lateral portions rufous. In the dried specimen the dorsal spines are pale red, papular areas dark red, madreporites light gray, oral spines dirty white. There are 15 rays and 8 madreporitic plates; R = 85 mm. and r = 51 mm.

Family Heliasteridae.

Heliaster kubiniji Xantus.

Heliaster kubiniji Xantus, 1860, p. 568.

Heliaster kubiniji, H. L. Clark, 1913, p. 201.

Type: U. S. N. M.

Type Locality: Cerro Blanco, off Cape San Lucas, Lower California.

General Range: Gulf of California. From shore to five fathoms.

Local Distribution: Two small specimens were taken in three feet of water at Santa Inez Point, Santa Inez Bay, on a sandy bottom.

Remarks: This species is a common littoral form in the Gulf of California. Each of the present specimens has 23 rays, R = 60 mm.; r = 33 mm. Color (dried) dark brown, spines pale pink fading to white.

Family Asteriidae.

Sclerasterias heteropaes Fisher.

Sclerasterias heteropaes Fisher, 1928, p. 112.

Type: Cat. No. E. 1427, U. S. N. M.

Type Locality: Albatross Station 4554, N. W. Point Pinos, Monterey Bay, California, in 70 to 80 fathoms.

General Range: Half Moon Bay to south of San Diego, California, and Clarion Island. From 27 to 85 fathoms.

Local Distribution: A total of 11 specimens was taken west of San José Point, Lower California, and off Clarion Island at 45 to 55 fathoms on bottoms composed of shale and of rock with coral, respectively.

Remarks: This species is interesting in that the young may have either five or six arms (Fisher, 1928, p. 115). In the largest R = 21 mm., smallest

R = 8 mm. The color of dried specimens is brown, with two whitish bands on each arm, the spines white. The specimens from Clarion Island establish a new southern limit for the known range of the species.

Material: Station 163: D-2 (2 young). Station 175: D-1 (9 young).

Class Ophiuroidea.

Family Ophiomyxidae.

Ophiomyxa panamensis Lütken & Mortensen.

Ophiomyxa panamensis Lütken & Mortensen, 1899, p. 182.

Type: Cat. No. 2642, M. C. Z. (cotypes).

Type Locality: Albatross Station 3397, Panama.

General Range: Gulf of California to Panama. From 50 to 85 fathoms.

Local Distribution: A total of 15 specimens was taken from Arena Bank and Gorda Banks at depths of 50 fathoms on rocky and crushed shell bottoms.

Remarks: Unfortunately the specimens are crushed and broken but there is no doubt of their identity even though their occurrence near Lower California extends the known range of the species 2,000 miles to the north. The color of these specimens when dried is old rose; the disk, however, is dark red and the arm spines have yellow tips.

Material: Station 136: D-27 (7 disks and fragments). Station 150: D-10 (8 disks and fragments).

Family Gorgonocephalidae.

Astrocaneum spinosum (Lyman).

Astrophyton spinosum Lyman, 1875, p. 29.

Astrocaneum spinosum, Döderlein, 1911, p. 92.

Type: Cat. No. 2912, M. C. Z.

Type Locality: West coast of Panama.

General Range: Panama to Lower California. From 10 to 46 fathoms.

Local Distribution: One specimen from Ceralbo Channel, (Station 137: D-1) at a depth of 46 fathoms.

Remarks: This specimen extends the known range of the species more than 2,000 miles to the north. The diameter of the disk is 30 mm., length of arm about 110 mm. The color of the dried specimen is pale brown with a dark, dorsal median line on arms.

Family Ophiacanthidae.

Ophiacantha pyriformis sp. nov.

(Text-figure 1).

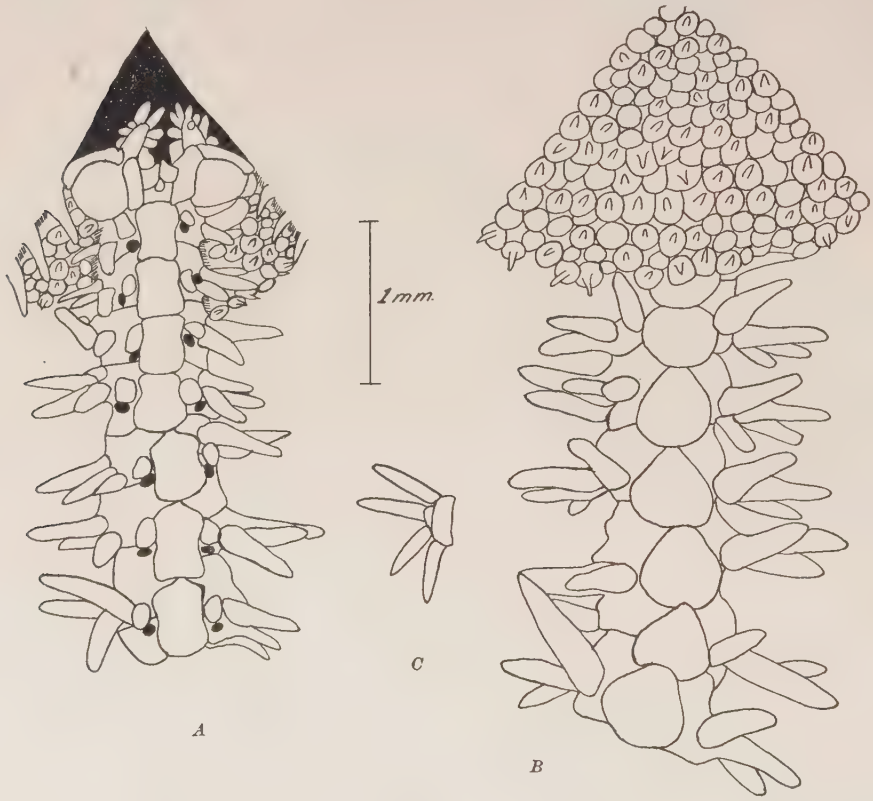
Diagnosis: Rays six; simple spinelets on disk scales; unique, well defined dorsal arm-plates; four short, stout, tapering arm-spines.

Description: Disk about 3 mm. in diameter, arms 6; old arms 13 mm. long; regenerated arms 6 mm. Disk covered with numerous, distinct, overlapping scales, each of the larger bearing a single, blunt, relatively smooth, tapering spinelet, less than 1 mm. in length; there is no definite arrangement in the distribution of spines. Radial shields covered with scales,

except at the distal margin. Basal upper arm-plates more or less circular, the second much larger than the first; subsequent plates becoming longer than wide but widest distally, pyriform, sharply defined, only slightly in contact with each other; the surface of all upper arm-plates is rough, like shagreen.

Interbrachial areas below covered with overlapping scales, some bearing short, blunt spines. Genital slits large. Oral shields oval, longer than broad, proximally more convex than distally. Adoral shields triangular, longer than broad, proximally pointed, increasing in width distally, meeting within in some areas, not in contact in others, due to regenerating rays. All plates more finely granulate than the upper arm plates. Teeth block-like and bluntly rounded, four in each column. Oral papillae two to four on each side of the jaw, according to the stage of growth, most proximal narrow and rounded; distally they become wider and flat with blunt tips; distal papilla widest. Second pair of oral tentacles with tentacle-scales.

First under arm-plate small, oval, distally and proximally convex; second and succeeding arm-plates longer than wide, sides slightly concave, proximal end pointed, distal margin broadly rounded; plates slightly in contact. Tentacle-scale single, large, oval and flat; distally it becomes slender and pointed. Side arm-plates large, narrowly separated above and below. Each



Text-figure 1.
Ophiacantha pyriformis sp. nov. **A**, oral side; **B**, aboral side; **C**, arm-spine arrangement.

plate bears four short, well spaced, smooth spines, tapering but blunt, the uppermost longest.

The color in dried alcoholic specimens is as follows: old arms and portion of the disk light brown; regenerated rays and parts of disk light gray; oral surface nearly white; arm-spines gray.

Type: M. C. Z. Cat. No. 5423 (holotype) and three paratypes (M. C. Z. 5424).

Type Locality: Clarion Island, Mexico.

Material: The holotype and three paratypes, taken off Clarion Island, (Station 163: D-1) at a depth of 20 fathoms on a bottom of rock and coral.

Remarks: Of the four specimens three have six arms, three large and three small, and one has three arms, the incomplete disk having four jaws. Evidently reproduction by fission when very young is the rule, but whether the adult has five or six arms, there is no means of knowing.

This species is readily distinguished from other species of the genus by the simple spinelets on the disk-scales, unique dorsal arm-plates and the four short stout arm-spines. It apparently is not closely allied to any known species, but additional material may show it to be the young of a larger, already named species.

Family Amphiuridae.

Amphiura arcystata H. L. Clark.

Amphiura arcystata H. L. Clark, 1911, p. 145.
Amphiura arcystata, Nielsen, 1932, p. 264.

Type: Cat. No. 3135, M. C. Z. (paratype).

Type Locality: Off Central California, *Albatross* Station 3132.

General Distribution: From California to the Gulf of California and Japan. From 30 to 330 fathoms.

Local Distribution: A total of seven specimens was taken east of Cedros Island and in Santa Inez Bay at 35 and 45 fathoms on muddy bottoms.

Remarks: The largest specimen is 12 mm. in disk diameter; while the longest arm measures 204 mm. The smallest specimen is 4 mm. across the disk and its longest arm is 40 mm. The dried specimens are light brown, the disk darker and radial shields lighter. This record extends the known range of the species to the Gulf of California, more than 1,200 miles to the south.

Material: Station 126: D-6 (3 adults). Station 143: D-4 (4 young).

Amphipholis squamata (Delle Chiaje).

Asterias squamata Delle Chiaje, 1828, p. 74.
Amphipholis squamata, Verrill, 1899, p. 312; Nielsen, 1932, p. 290.

Type: Unknown.

Type Locality: Mediterranean Sea, probably Naples.

General Range: Cosmopolitan, the most widely distributed of the brittle-stars. From shore to 100 fathoms.

Local Distribution: One specimen was taken east of Cedros Island (Station 125: D-1) at a depth of 44 fathoms on a muddy bottom.

Remarks: The disk diameter of the single specimen is 3 mm. with length of arms 7 mm. The disk is light gray, the arms light cream color in the dry specimen.

Amphiodia urtica (Lyman).

Amphiura urtica Lyman, 1860, p. 195.
Amphiodia urtica, Verrill, 1899, p. 313; Nielsen, 1932, p. 279.

Type: Never designated.

Type Locality: Puget Sound, Washington.

General Range: From Shumagin Islands, Alaska, to Lower California. From 15 to 50 fathoms.

Local Distribution: Three young specimens were taken east of Cedros Island (Station 125: D-1) at a depth of 44 fathoms on a muddy bottom.

Remarks: The diameter of the disk in the largest specimen is 4 mm., while that of the smallest is 2 mm. The arms are 17 mm. in length. The disk is gray and the arms are cream color in the present material. This is the farthest south the species has been recorded.

Ophiactis savignyi (Müller & Troschel).

Ophiolepis savignyi Müller & Troschel, 1842, p. 95.
Ophiactis savignyi, Ljungman, 1867, p. 323; Nielsen, 1932, p. 257.

Type: Unknown.

Type Locality: Egypt.

General Range: World-wide in the tropics; on the Pacific coast from San Pedro, California, to Panama. From shore to 27 fathoms.

Local Distribution: One young specimen was taken from Clarion Island (Station 163: D-1) at a depth of 20 fathoms on a bottom formed of coral and rock.

Remarks: This is a common tropical species, frequently found in sponges. The disk diameter of the present specimen is only 1.5 mm., length of arms, 7 mm. The dried specimen has the disk mottled green and black as usual and the arms marked with alternating bands of green and light brown.

Ophiopholis bakeri McClendon.

Ophiopholis bakeri McClendon, 1909, p. 41.
Ophiopholis bakeri, Nielsen, 1932, p. 261.

Type: Probably in the University of California, Berkeley.

Type Locality: La Jolla, California.

General Range: From British Columbia to Lower California. From 41 to 68 fathoms.

Local Distribution: A total of 15 adults was taken west of San José Point, Lower California (Station 175: D-1, 8 adults; D-2, 7 adults) at 45 fathoms on shaley and rocky bottoms.

Remarks: The diameter of the largest specimen is 7 mm., length of arms 32 mm.; the disk diameter of the smallest specimen is 2 mm., length of arms 7 mm. The dried specimens have a pink disk with white or gray markings. The arms, orange in life, are pink with an occasional light band; the armspines are white or gray.

Family Ophiotrichidae.

Ophiothrix galapagensis Lütken & Mortensen.

Ophiothrix galapagensis Lütken & Mortensen, 1899, p. 181.

Type: Cat. No. 2340, M. C. Z. (cotype).

Type Locality: Near the Galápagos Islands, *Albatross* station 3405.

General Range: Galápagos Islands, Clarion Island and the Gulf of California. From 20 to 75 fathoms.

Local Distribution: A total of 42 specimens was taken from Gorda Banks, Arena Bank, Santa Inez Bay and Clarion Island between 35 and 75 fathoms on sandy, muddy and rocky bottoms.

Remarks: These specimens are the first to be collected since 1899 when the species was described from three specimens. The known range of this species has been extended to Clarion Island and the Gulf of California, more than 2,000 miles to the north, by the present record.

All of the specimens are larger than the type, which had a diameter of only 5 mm. The largest specimen in the present series is 13 mm. in diameter. The arm length is about 75 mm.

In the live specimens the disk was purplish blue above spotted with red; arms pinkish-orange, each with a double line of dark oblong spots on upper surface; oral surface white. The color of the dried specimens varies greatly; the disk ranges from cream to maroon with white central markings; medial shields pink with red markings bordering the plates as a marginal line or irregular spotting; disk orally and arm-spines white; arms pink with a median longitudinal white line on dorsal surface.

This species occurred locally in great swarms. About 23,000 specimens, weighing 100 pounds altogether, were taken in a single 10-minute dredge (Station 150: D-18); at Station 150: D-16, 1,682 specimens, and at Station 150: D-4, 360 were captured.

O. galapagensis is related to *O. spiculata,* from which it differs by the raised and naked radial shields, by the pinkish color and red markings, by the larger size, longer spines and shape of the arm plates.

Material: Station 136: D-7 (7 adults), D-13 (1 adult), D-23 (1 adult), D-24 (2 adults). Station 142: D-3 (4 adults), Station 146: D-1 (3 adults). Station 147: D-2 (1 adult). Station 150: D-4 (8 crushed adults), D-16 (2 adults), D-18 (7 adults and fragments). Station 163: D-2 (6 adults, poor condition).

Ophiothrix spiculata Le Conte.

Ophiothrix spiculata Le Conte, 1851, p. 318.

Ophiothrix spiculata, Nielsen, 1932, p. 251.

Type: Cat. No. 2415, M. C. Z. (cotypes).

Type Locality: Panama (west coast).

General Range: From Monterey Bay, California, to the Bay of Sechura, Peru. From shore to 45 fathoms.

Local Distribution: A total of 18 specimens was taken east of Cedros Island, on Arena Bank and in Santa Inez Bay, between 1½ and 45 fathoms on sandy and muddy bottoms.

Remarks: These specimens are larger than the types. In life the arms are banded with pink and maroon or brown. The general color varies from light gray and brown to red in the dry specimens. The most colorful of the series has blue radial shields and red disk spines; the arms are blue with a red band about every fourth arm-plate. The arm-spines are dark at the base but become lighter toward the tips. The diameter of the largest specimen is 12 mm., arm length about 40 mm. The smallest specimen has a disk diameter of 5 mm.

Material: Station 126: D-3 (1 adult). Station 128: D-1 (5 adults). Station 136: D-1 (4 adults), D-14 (1 adult), D-23 (1 adult). Station 144: D-4 (6 adults).

Family Ophiochitonidae.

Ophionereis annulata (Le Conte).

Ophiolepis annulata Le Conte, 1851, p. 317.
Ophionereis annulata, Lyman, 1860, p. 203; Nielsen, 1932, p. 309.

Type: Cat. No. 1584, M. C. Z.

Type Locality: West coast of Panama.

General Range: From San Diego, California, to Panama and the Galápagos Islands; Clarion Island. From shore to 20 fathoms.

Local Distribution: Two young specimens were taken off Clarion Island (Station 163: D-1) at a depth of 20 fathoms on a bottom formed of coral and rock.

Remarks: The disk diameters of the specimens are 5 mm. and 4 mm. respectively. The color (dried) is much lighter than that of the types. The disk and arms are pale bluff, the latter banded with brown every fourth or fifth segment.

Ophionereis eurybrachiplax H. L. Clark.

Ophionereis eurybrachiplax H. L. Clark, 1911, p. 173.
Ophionereis eurybrachiplax, Nielsen, 1932, p. 309.

Type: Cat. No. 25589, U. S. N. M. (paratypes Cat. Nos. 3175, 3176, M. C. Z.)

Type Locality: Off California.

General Range: From Central California to Lower California. From 27 to 45 fathoms.

Local Distribution: Two specimens were taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: Upon comparison these specimens proved to be almost identical with the types. Their disk diameters are 15 mm. and 20 mm. respectively. The arms are broken but they were about 120 mm. long. The color of the dried specimens is brown; the distal portion of the arms has a light gray median line and lateral markings dorsally.

These specimens extend the known range of the species more than 200 miles to the south along the Pacific coast.

Family Ophiocomidae.

Ophiocoma aethiops Lütken.

Ophiocoma aethiops Lütken, 1859, p. 145.
Ophiocoma aethiops, Nielsen, 1932, p. 246.

Type: Probably in Copenhagen.

Type Locality: West coast of Panama.

General Range: From Lower California to Panama and the Galápagos Islands; Gulf of California (Arena Bank); Clarion Island.

Local Distribution: A total of nine specimens was taken off Arena Bank at 2½ fathoms in coral (*Pocillopora ligulata*) and in tide pools on Clarion Island.

Remarks: The largest specimen has a disk diameter of 30 mm.; the smallest disk diameter is 13 mm. The color of the dried specimens is black; only the largest specimen has a gray center, 15 mm. in diameter, on the dorsal side.

Material: Station 136: D-33 (8 broken adults). Tide pools, Clarion Island: (1 adult).

Ophiocoma alexandri Lyman.

Ophiocoma alexandri Lyman, 1860, p. 256.
Ophiocoma alexandri, Nielsen, 1932, p. 248.

Type: Cat. No. 1825, M. C. Z. (holotype).

Type Locality: Acapulco, Mexico.

General Range: From Lower California to Panama and the Galápagos Islands; Clarion Island. From shore to 5 fathoms.

Local Distribution: One adult from tide pools, Clarion Island.

Remarks: The diameter of the disk is 16 mm., length of arms about 100 mm. The dried specimen is brown with alternating light and dark brown arm bands every few segments.

Family Ophiodermatidae.

Ophioderma panamense Lütken.

Ophioderma panamense Lütken, 1859, p. 91.
Ophioderma panamense, Nielsen, 1932, p. 327.

Type: Probably in Copenhagen.

Type Locality: West coast of Panama.

General Range: From San Pedro, California, to Payta, Peru, and the Galápagos Islands. From shore to 10 fathoms.

Local Distribution: One broken specimen was taken from the shore of Santa Inez Bay.

Remarks: In this dried specimen, the 19 mm. disk is brown and the arms are slate brown.

Ophioderma variegatum Lütken.

Ophioderma variegatum Lütken, 1856, p. 21.
Ophioderma variegatum, Nielsen, 1932, p. 350.

Type: Probably in Copenhagen.

Type Locality: Realejo, Nicaragua (west coast).

General Range: From San Diego, California, to Panama, also at Clarion Island. From shore to 60 fathoms.

Local Distribution: A total of 11 specimens was taken from Gorda Banks, Arena Bank, Santa Inez Bay and Clarion Island from shore to 60 fathoms on muddy, sandy and rocky bottoms.

Remarks: This series ranges from 7 mm. in diameter to 15 mm.; the arms of the largest specimen are about 55 mm. long. One specimen has only four rays. The common color combination is a red disk dorsally with green, white and narrow black bands on the arms. The oral surface is light cream color, almost white. Two smaller specimens have mottled white and brown disks; the arms are banded, brown and brown with white speckles. In life these specimens were probably more highly colored.

Material: Station 136: D-24 (4 adults), D-26 (3 adults). Station 142: D-1 (2 adults). Station 150: D-18 (1 young). Tide-pools, Clarion Island (1 adult).

Schizoderma diplax Nielsen.

Schizoderma diplax Nielsen, 1932, p. 335.

Type: Copenhagen.

Type Locality: Perlas Island, Gulf of Panama.

General Range: From Lower California to Panama. From shore to 60 fathoms.

Local Distribution: A total of 20 specimens was taken from Arena Bank, Gorda Banks and Santa Inez Bay between 29 and 60 fathoms, usually on muddy, rarely on sandy, bottoms.

Remarks: This fine series ranges from 7 mm. to 15 mm. in disk diameter. The color (dried) is light brown with dark brown and gray markings on the disk; the arms are gray with brown bands every two to four segments. This series extends the known range of the species more than 2,000 miles to the north, the first record from the Gulf of California.

Material: Station 136: D-1 (1 adult), D-14 (1 adult). Station 142: D-1 (3 adults), D-2 (2 adults), D-3 (1 adult), D-4 (2 adults). Station 143: D-1 (3 adults). Station 150: D-8 (5 adults), D-9 (2 adults).

Diopederma danianum (Verrill).

Ophiura danianum Verrill, 1867a, p. 254.

Diopederma danianum, H. L. Clark, 1913, p. 206; Nielsen, 1932, p. 339.

Type: Peabody Museum, New Haven.

Type Locality: La Union, Salvador (west coast).

General Range: Lower California to Salvador, and the Perlas Islands, Gulf of Panama. From 3 to 25 fathoms.

Local Distribution: One adult was taken in San Lucas Bay (Station 135: D-20) at a depth of 3 fathoms on a sandy bottom.

Remarks: This individual has a disk diameter of 11 mm. The arms are about 33 mm. long. The color of the disk is gray with white and brown markings; the arms are light gray with brown transverse bands every two to three arm segments; the ventral surface is white.

Ophiuroconis bispinosa sp. nov.

(Text-figure 2).

Diagnosis: Rays five; disk covered dorsally and ventrally with fine granulations; two hyaline arm-spines, three or four oral papillae, tentacle-scale single, scoop-shaped, large, longer than upper arm-plates near the arm-tips.

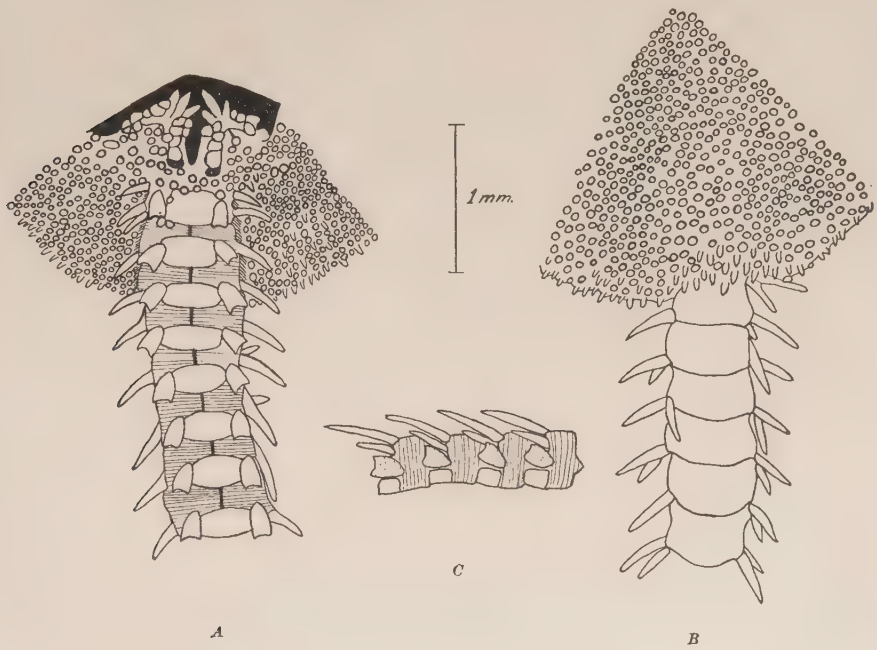
Description: Disk 3 mm. in diameter; arms 17 mm. long. Disk circular, thick; radial shields depressed; entire dorsal surface covered with a fine granulation becoming heavier and longer at the margins and over the radial shields. Arms long and slender. Basal upper arm-plates quadrangular, broader than long, distal margins wider than proximal, slightly convex; lateral margins nearly straight; plates broadly in contact throughout, but distally twice as long as wide with distal margin convex and lateral slightly concave.

Interbrachial areas below heavily granulated distally, more sparsely proximally. Genital slits large, but genital plates concealed. Oral shields, mouth shields and proximal ventral arm-plates covered but not concealed by scattered coarse granules; these may occur as far as the distal margin of the fourth under arm-plate. Oral shields triangular with an acute proximal point and concave sides; distal margin smoothly rounded. Adoral plates narrow

and long, about three times as long as wide, acutely pointed proximally and barely meeting within. Oral plates much larger than adorals and covered with granules.

Oral papillae three on each side or possibly four; owing to the granules on the oral plates which are irregular in size, form and position, and to the size and position of the oral tentacles, with accompanying scales, it is difficult if not impossible to be sure how many oral papillae there are. If each oral tentacle is assigned a scale, there are only three papillae on each side, but the large nearly circular scale associated with the second tentacle has the position and relationship of a distal oral papilla and may be considered as such. In that case, there are four oral papillae on each side, the distalmost much the longest; proximal long, slender, acute, pointing toward the mouth; second scale-like, blunt. Tentacle-scale single, relatively very large and of usual form; longer than wide, truncate, markedly convex parallel to its long axis, it resembles a small scoop; distally, it is increasingly longer and narrower so that near the tip of the arm it is two or even three times as long as wide, greatly exceeding the under arm-plates and finally becoming equal to the whole arm-segment. The scales are translucent, concentrically striated.

First under arm-plate well covered with granules; second shield-shaped, hexagonal, with a short straight proximal margin, at each end of which is a markedly concave side, connecting it with the slightly convex lateral margins, which merge in a convex distal end; third and succeeding plates wider than long, with proximal and distal margins slightly convex, and lateral margins slightly concave; distally the plates become quadrangular and widely separated by the side arm-plates. The latter are large, concentrically striated, not meeting above, but fully in contact below; each plate carries on its distal margin two tapering, but not very acute hyaline spines, the



Text-figure 2.

Ophiuroconis bispinosa sp. nov. **A**, oral side; **B**, aboral side; **C**, ventro-lateral view of arm showing spines and tentacle-scale.

upper being the longer, about the length of an arm segment, or distally a trifle more. The union of the side arm-plates below forms a slight ridge, which extends to the arm-tip.

The color dried from alcohol is as follows: disk cream color with irregular light brown markings over the radial shields. Arms light tan with bands of brown or black, two to four segments wide (usually two), alternating with a light colored area; near disk, the light and dark bands are four segments wide, but distally they are only half as wide. Lower surface white, with some under arm-plates (usually in pairs) faintly dusky.

Type: Cat No. 5422, M. C. Z.

Material: One juvenile (the holotype) from San Lucas Bay (Station 135: D-20) at a depth of 3 fathoms on a sandy bottom.

Remarks: According to Matsumoto's classification this specimen belongs to *Ophiuroconis,* although it is not typical. Additional material may prove it to be the young of some known species, but in view of its striking peculiarities this seems highly improbable. Compared with specimens of young *Ophioderma,* it is decidedly not the young of any member of that genus.

Family Ophiolepididae.

Ophiura lütkeni (Lyman).

Ophioglypha lütkeni Lyman, 1860, p. 197.

Ophiura lütkeni, McClendon, 1909, p. 37; Nielsen, 1932, p. 316.

Type: Cat. No. 1039, U. S. N. M.

Type Locality: Puget Sound, Washington.

General Range: From Alaska to Lower California. From 15 to 100 fathoms.

Local Distribution: 1,844 young individuals were taken east of Cedros Island (Station 125: D-1) at a depth of 44 fathoms on a muddy bottom. In addition, several bushelsful taken in the same net, were thrown overboard.

Remarks: The range in size of these specimens is from 2 mm. to 7 mm. disk diameter. The color (dried) is gray dorsally. In most specimens the disk has one or more white spots; if one, it is usually located in the center. The armspines and oral surface are white.

This record extends the known range south to Lower California.

Ophiolepis crassa Nielsen.

Ophiolepis crassa Nielsen, 1932, p. 324.

Type: Copenhagen.

Type Locality: Gulf of Panama.

General Range: From the Gulf of California to Panama. From 4 to 75 fathoms.

Local Distribution: A total of 35 specimens was taken off Cape San Lucas, on Gorda Banks, on Arena Bank and in Santa Inez Bay between 40 and 75 fathoms on muddy, sandy and rocky bottoms.

Remarks: This series ranges from 6 mm. to 15 mm. in disk diameter. The color of the dried specimens is tan with light and dark mottlings, the arms light tan with broad brown bands on every third segment; the short arm-spines are light in color; color in life similar.

These are the first specimens of *crassa* to be recorded from the Gulf of California; the known range is thus extended about 2,000 miles to the north.

Material: Station 136: D-1 (1 adult), D-23 (3 adults), D-24 (6 adults), D-26 (5 adults). Station 150: D-8 (2 adults), D-16 (6 adults), D-18 (9 broken adults). Station 151: D-1 (2 adults). Station 142: D-1 (1 adult).

Class Echinoidea.

Family Cidaridae.

Eucidaris thouarsii (Agassiz & Desor).

Cidaris thouarsii L. Agassiz & Desor, 1846, p. 326.

Eucidaris thouarsii, Mortensen, 1928, p. 393.

Type: Unknown.

Type Locality: Unknown.

General Range: Lower California to Panama and the Galápagos Islands. From shore to 50 fathoms.

Local Distribution: A total of 17 specimens was taken from Arena Bank and Clarion Island between shore and 50 fathoms on muddy bottoms, in coral (*Pocillopora ligulata*) and in a tide-pool.

Remarks: This species is common in the Panamic region, but the young are usually well concealed in coral heads. It has not been previously recorded below 20 fathoms. The present series ranges from 7 mm. to 38 mm. in diameter. Color of dried adults: test almost black, spines purple usually covered with white bryozoan colonies. Young: test reddish-brown, spines red with one to five white bands.

Material: Station 136: D-1 (4 young), D-12 (2 young), D-23 (2 young), D-24 (5 young), D-26 (2 young), D-33 (1 adult). Clarion Island tide-pool: (1 adult).

Hesperocidaris perplexa (H. L. Clark).

Tretocidaris perplexa H. L. Clark, 1907, p. 205.

Hesperocidaris perplexa, Mortensen, 1928, p. 421.

Type: Cat. No. 188, M. C. Z.

Type Locality: Gulf of California.

General Range: Gulf of California and Clarion Island. From 30 to 80 fathoms.

Local Distribution: A total of 12 specimens was taken on Gorda Banks, Arena Bank and in Santa Inez Bay between 40 and 80 fathoms on muddy and sandy bottoms.

Remarks: This series is well graduated in size from 11 mm. to 52 mm. in diameter. Color of the dried test, green with purple secondary spines and dull green, pink-tipped primary spines.

Material: Station 136: D-1 (1 adult), D-7 (1 adult), D-17 (2 adults). Station 142: D-4 (1 adult). Station 150: D-2 (4 young), D-13 (1 young), D-18 (2 young).

Family Centrechinidae.

Centrechinus mexicanus (A. Agassiz).

Diadema mexicanum A. Agassiz, 1863, p. 20.

Diadema mexicanum, H. L. Clark, 1902, p. 526.

Centrechinus mexicanus, H. L. Clark, 1921. Echinoderm Fauna of Torres Strait, p. 145.

Type: Cat. No. 635, M. C. Z. (cotypes).

Type Locality: Acapulco, Mexico.

General Range: From Puget Sound to Panama and the Galápagos Islands. From shore to 20 fathoms.

Local Distribution: A total of seven specimens was taken from Clarion Island (Station 163: D-1, 6 young; Sulphur Bay, 1 adult) between 2 and 20 fathoms in rocks and coral.

Remarks: These specimens consist of six young and one adult which has a diameter of only 27 mm., while the longest spine is 68 mm. The spines are dark in color, lacking the alternate bands of white found on younger specimens.

Of all the animals encountered in pearl diving, the divers fear this echinoderm most. The spines, which are easily broken when in contact with the body, are covered with a poisonous mucous and being exceedingly sharp penetrate human skin easily. There the tips break off at once and, being retrorsely barbed, it is nearly impossible to remove them; they are, however, rapidly absorbed by healthy tissue. The poison is a bad irritant, but the quantity borne by any one spine is so small that serious results occur only when a great number penetrate at one time; yet the wound caused by one is extremely painful. To add to the hazard the animal is sensitive to light and the passing of a shadow will cause it to project the spines from its well concealed hiding place in coral and rock formations. The present writer has been stung several times when collecting echinoderms. The injured finger soon became inflamed, swollen and discolored. A smarting, burning sensation remained in the finger for more than half an hour, accompanied by a nauseated feeling in the stomach.

Centrostephanus coronatus (Verrill).

Echinodiadema coronata Verrill, 1867a, p. 294.

Centrostephanus coronatus, A. Agassiz, 1872, p. 97; H. L. Clark, 1923, p. 158.

Type: Probably in the Peabody Museum, New Haven.

Type Locality: Cape San Lucas, Lower California.

General Range: From Santa Catalina Island, California, to Cape San Lucas. From shore to 34 fathoms.

Local Distribution: One specimen was taken on Arena Bank (Station 136: D-5) at a depth of 34 fathoms on a sandy bottom with abundant weed.

Remarks: Test 7 mm. high; diameter 17 mm.; longest spine 33 mm. Color in alcohol, test purple, secondary spines light yellow and pinkish, primary spines white with purple alternating bands. In life all spines were banded with maroon and buff. The spines are brittle, often breaking at the slightest pressure, and are covered with crowded whorls of minute prickles.

Family Arbaciidae.

Arbacia incisa (A. Agassiz).

Echinocidaris incisa A. Agassiz, 1863, p. 20.

Arbacia incisa, H. L. Clark, 1913, p. 220.

Type: Cat. No. 467, M. C. Z. (cotype).

Type Locality: Guaymas, Mexico.

General Range: From Magdalena Bay, Lower California, to Zorritos, Peru; Gulf of California; Galápagos Islands. From shore to 29 fathoms.

Local Distribution: A total of six specimens was taken from Arena Bank and Santa Inez Bay between shore and 29 fathoms on sandy and muddy bottoms and in coral (*Pocillopora ligulata*).

Remarks: This is a common species on the west coast of America. The series ranges in size from 6 to 18 mm. in diameter. The color is purple to black; one specimen is gray with purple central markings and light purple spines.

Material: Station 141: D-1 (2 young), D-2 (1 adult). Station 143: D-1 (1 young). Santa Inez shore: (1 young). Station 136: D-33 (1 young).

Family Echinidae.

Lyctechinus anamesus H. L. Clark.

Lyctechinus anamesus H. L. Clark, 1912, p. 254.

Type: Cat. No. 3916, M. C. Z. (cotype).

Type Locality: Off San Diego, California, *Albatross* Station 2930, 60 fathoms.

General Range: From Santa Barbara, California, to Point San Bartolome Bay, Lower California, and Guadeloupe Island. From 30 to 60 fathoms.

Local Distribution: A total of 24 specimens was taken east of Cedros Island off San José Point, Lower California, between 38 and 45 fathoms on muddy and shaley bottoms.

Remarks: A very interesting series, ranging in diameter from 10 to 21 mm. Dried from alcohol the spines are light yellowish green, the test gray with a purplish tinge in the interambulacra. In life the specimens were entirely white.

Material: Station 126: D-2 (1 young, 1 test), D-3 (2 adults). Station 127: D-1 (9 adults). Station 175: D-1 (11 adults).

Tripneustes depressus A. Agassiz.

Tripneustes depressus A. Agassiz, 1863, p. 24.

Tripneustes depressus, H. L. Clark, 1912, p. 285.

Type: Unknown.

Type Locality: Guaymas, Mexico.

General Range: Gulf of California, Socorro, Clarion and the Galápagos Islands. From shore to 40 fathoms.

Local Distribution: One adult specimen was taken from Clarion Island in the tide-pools west of the landing.

Remarks: This specimen has a H. D. of 86 mm. and a V. D. of 46 mm. The test is purple, covered with short white spines.

Family Strongylocentrotidae.

Strongylocentrotus fragilis Jackson.

Strongylocentrotus fragilis Jackson, 1912, p. 128.

Strongylocentrotus fragilis, H. L. Clark, 1912, p. 354, pl. 113, figs. 3-6.

Type: Cat. No. 3668, M. C. Z.

Type Locality: Catalina Island, California.

General Range: From Oregon to northern Lower California. From 45 to 638 fathoms.

Local Distribution: One young specimen was taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: There is only a single specimen at hand and this is but 9 mm. in diameter. The test is reddish, the spines red with white tips. This species has an exceedingly fragile test which is easily crushed in dredging. The known range is extended south into Mexico by this specimen.

Family Echinometridae.

Echinometra oblonga de Blainville.

Echinus oblonga de Blainville, 1825, p. 95.

Echinometra oblongus, de Blainville, 1830, p. 206; H. L. Clark, 1912, p. 373.

Type: Unknown.

Type Locality: Unknown.

General Range: Hawaiian, Paumotus and Gilbert Islands and westward to Mauritius; also Clarion Island. From shore to 7 fathoms.

Local Distribution: Two adults and one young were taken from Sulphur Bay, Clarion Island, in coral (*Pocillopora*) at a depth of 2 fathoms.

Remarks: The smallest specimen is 9 mm. high and 17 mm. long, the largest 28 mm. high and 61 mm. long. The spines are short, blunt and almost black in color; the test is dark purple. These individuals do not differ essentially from other specimens previously taken at Clarion Island.

Family Clypeastridae.

Clypeaster speciosus Verrill.

Clypeaster speciosus Verrill, 1870, p. 95.

Clypeaster speciosus, H. L. Clark, 1914, p. 31.

Type: Cat. No. 2203, M. C. Z. (cotype).

Type Locality: La Paz, Lower California.

General Range: Gulf of California and the Galápagos Islands. From shore to 10 fathoms.

Local Distribution: One adult and a dead bleached test were taken from Santa Inez Point, Santa Inez Bay.

Remarks: The adult is 77 mm. in length, 68 mm. in width and 18 mm. in height. The color of the dried specimen is dark purple, almost black. The bleached test devoid of spines is 51 mm. in length, 44 mm. in width, 13 mm. in height.

Clypeaster europacificus H. L. Clark.

Clypeaster europacificus H. L. Clark, 1914, p. 27.

Types: Cat. Nos. 4179, 4180, M. C. Z.

Type Localities: Gulf of California and Gulf of Panama.

General Range: Gulf of California to Gulf of Panama, Clarion Island and Galápagos Islands. From 7 to 50 fathoms.

Local Distribution: A total of six specimens was taken from Arena Bank and Santa Inez Bay between 29 and 50 fathoms on sandy and muddy bottoms.

Remarks: The smallest specimens measure 29, 34, 53 and 54 mm. in length; the larger ones 163 and 166 mm. The larger specimens, dull green

in life, are greenish brown when dried; the smaller have a purplish tinge, although the spines are green.

Material: Station 136: D-1 (1 adult), D-26 (1 young). Station 142: D-4 (1 adult). Station 143: D-1 (3 young).

Family Scutellidae.

Encope grandis L. Agassiz.

Encope grandis L. Agassiz, 1841, p. 57.
Encope grandis, H. L. Clark, 1914, p. 75.

Type: Unknown.

Type Locality: Gulf of California. From shore to 10 fathoms.

Local Distribution: One young specimen was taken in San Lucas Bay (Station 135: D-20) at a depth of three fathoms on a sandy bottom, and two bleached tests from Santa Inez Point, Santa Inez Bay.

Remarks: The tests are 76 and 94 mm. in length. The larger specimen had evidently been dead for some time as the surface of the test is scarred by worms. The smaller test is well preserved. The very young specimen, which is probably *grandis,* measures 22 mm. in length and 23 mm. in width. It corresponds well with other small specimens in the M. C. Z. collection.

Encope micropora L. Agassiz.

Encope micropora L. Agassiz, 1841, p. 50.
Encope micropora, H. L. Clark, 1914, p. 74.

Type: Unknown.

Type Locality: Apparently the Galápagos Islands.

General Range: From Lower California to the Bay of Sechura, Peru, and the Galápagos Islands. From shore to 45 fathoms.

Local Distribution: One adult specimen was taken on Arena Bank (Station 136: D-1) at a depth of 45 fathoms on a muddy bottom.

Remarks: This specimen measures 100 mm. in width and 91 mm. in length. The margin of the test is irregular, having been bitten off or broken. The color of the dried individual is a light mouse gray.

Family Spatangidae.

Brissopsis pacifica (A. Agassiz).

Toxobrissus pacificus A. Agassiz, 1898, p. 82.
Brissopsis pacifica, Mortensen, 1907, p. 44; H. L. Clark, 1914, p. 203.

Type: Cat. No. 3063, M. C. Z.

Type Locality: Off Panama, 7° 12′ 20″ N. Lat., 80° 55′ W. Long. 182 fathoms.

General Range: Southern California to Panama. From 38 to 284 fathoms.

Local Distribution: A total of five specimens was taken east of Cedros Island, and off San José Point, Lower California, between 38 and 56 fathoms on muddy and shaley bottoms.

Remarks: Two of the specimens are badly crushed. The smallest individual is 16 mm. long, 13 mm. wide and 9 mm. high; the largest is 51 mm.

long, 42 mm. wide and 25 mm. high. The color in life was white; in alcohol it is light brown, the peripetalous fasciole is almost black; dried specimens are of a greenish-brown tinge.

Material: Station 126: D-6 (1 young, 1 adult), D-9 (fragments of an adult). Station 127: D-1 (fragments of an adult). Station 175: D-1 (1 young).

Meoma grandis Gray.

Meoma grandis Gray, 1851, p. 132.
Meoma grandis, H. L. Clark, 1917, p. 220.

Type: Probably in the British Museum.

Type Locality: "Australia" (Captain E. D. Belcher). Probably the west coast of tropical America.

General Range: Gulf of California and the west coast of Mexico. From 20 to 60 fathoms.

Local Distribution: Two specimens and fragments of another were taken on Arena Bank, Gorda Banks and in Santa Inez Bay, between 40 and 60 fathoms on muddy bottoms.

Remarks: The larger specimen has a length of 100 mm., width of 92 mm. and height of 47 mm. The smaller specimen is 90 mm. long, 82 mm. wide and 40 mm. high. The color of the dried specimens is brown with a purplish tinge, spines greenish-brown, tips of spines yellow.

Material: Station 136: D-23 (1 adult). Station 141: D-4 (1 adult). Station 150: D-18 (fragments of an adult).

Lovenia cordiformis A. Agassiz.

Lovenia cordiformis A. Agassiz, 1872, p. 57.
Lovenia cordiformis, H. L. Clark, 1917, p. 254.

Type: Cat. No. 3188, M. C. Z. (cotype).

Type Locality: Guaymas, Mexico.

General Range: From Santa Barbara, California, to Guayaquil, Ecuador, Galápagos Islands and Hawaiian Islands. From 8 to 54 fathoms.

Local Distribution: A total of five specimens was taken east of Cedros Island and in Santa Inez Bay between 25 and 40 fathoms on muddy and sandy-mud bottoms.

Remarks: This interesting series contains four young, the smallest being 16 mm. in length, 11 mm. in width and 8 mm. in height. The largest specimen is 39 mm. long, 30 mm. wide and 16 mm. high. In life the specimens ranged from grayish-green to white. The color of the dried material is gray, the large spines purplish. There are indubitable specimens of this species in the M. C. Z. from Maui, Hawaiian Islands.[3]

Material: Station 126: D-3 (1 adult). Station 143: D-4 (4 young).

Bibliography.

Agassiz, A.

1863 List of the Echinoderms sent to different Institutions in Exchange for other specimens, with annotations. *Bull. M.C.Z.*, vol. 1, pp. 17-28.

1872 Revision of the Echini. *Ill. Catal. Mus. Comp. Zool.*, vol. VII, 4 parts, pp. 1-162, pls. 1-94, 69 woodcuts.

[3] Not yet recorded in the literature, as far as I am aware.

1898 A Preliminary Report on the Echini. *Bull. Mus. Comp. Zool.*, vol. XXXII, no. 5, pp. 71-82, pls. 1-13.

AGASSIZ, A. & CLARK, H. L.

1907 The Cidaridae. *Mem. Mus. Comp. Zool.*, vol. XXXIV, no. 1, pp. 1-42, pls. 1-42.

1908 The Salenidae, Arbaciadae, Aspidodiadematidae, and Diadematidae. *Mem. Mus. Comp. Zool.*, vol. XXXIV, no. 2, pp. 49-133, pls. 43-59.

1909 The Echinothuridae. *Mem. Mus. Comp. Zool.*, vol. XXXIV, no. 3, pp. 141-204, pls. 60-89.

AGASSIZ, L.

1841 Echinites, Famille des Clypeastroides, des Scutelles. Monographies d'Echinodermes, pp. 1-151, pls. 1-27.

AGASSIZ, L. & DESOR, E.

1846 Catalogue Raisonné des Familles, des Genres et des Espèces de la Classe des Echinoderms. *Ann. Sci. Nat.*, ser. 3, vol. 6, pp. 305-374, pls. 16-17; *ibid.* vol. 7, pp. 129-168; *ibid.* vol. 8, pp. 5-35.

BLAINVILLE, H. M. D. DE

1825 Oursins in: Dictionaire des Sciences Naturelles, Paris, 1816-1830, 60 vols., vol. 37, pp. 59-168.

1830 Echinodermaires in: *ibid*, vol. 60, pp. 169-245.

CLARK, A. H.

1907 Descriptions of New Species of Recent Unstalked Crinoids from the North Pacific Ocean. *Proc. U. S. Nat. Mus.*, vol. XXXIII, pp. 69-84.

1916 Six New Starfishes from the Gulf of California and Adjacent Waters. *Proc. Biol. Soc. Washington*, vol. XXIX, pp. 51-62.

1921 A Monograph of Existing Crinoids. Vol. I. The Comatulids, Part 2. *Bull. U. S. Nat. Mus.*, no. 82, pp. 1-77, pls. 1-57, figs. 1-949.

CLARK, H. L.

1902 Echinodermata, Papers from the Hopkins-Stanford Galápagos Expedition, 1898-1899. *Proc. Washington Acad. Sci.*, vol. IV, pp. 521-531.

1907 The Cidaridae. *Bull. M.C.Z.*, vol. 51, pp. 165-230, pls. 1-11.

1910 The Echinoderms of Peru. *Bull. Mus. Comp. Zool.*, vol. LII, no. 17, pp. 321-358, pls. 1-14.

1911 North Pacific Ophiurans in the Collection of the United States National Museum. *Bull. U. S. Nat. Mus.*, no. 75, pp. 1-295, figs. 1-144.

1912 The Pedinidae, Phymosomatidae, Stomopneustidae, Echinidae, Temnopleuridae, Strongylocentrotidae, and Echinometridae. *Mem. Mus. Comp. Zool.*, vol. XXXIV, no. 4, pp. 213-385, pls. 90-121.

1913 Echinoderms from Lower California with Descriptions of New Species. *Bull. Am. Mus. Nat. Hist.*, vol. XXXII, art. VIII, pp. 185-236, pls. 44-46.

1914 The Clypeastridae, Arachnoididae, Laganidae, Fibulariidae, and Scutellidae. *Mem. Mus. Comp. Zool.*, vol. XLVI, no. 1, pp. 9-78, pls. 122-143.

1915 Catalogue of Recent Ophiurans. *Mem. Mus. Comp. Zool.*, vol. XXV, no. 4, pp. 165-367, pls. 1-20.

1917 The Echinoneidae, Nucleolitidae, Urechinidae, Echinocorythidae, Calymnidae, Pourtalesiidae, Palaeostomatidae, Aeropsidae, Palaeopneustidae, Hemiasteridae and Spatangidae. *Mem. Mus. Comp. Zool.*, vol. XLVI, no. 2, pp. 91-269, pls. 144-161.

1921 The Echinoderm Fauna of Torres Strait: Its Composition and Its Origin. *Dep. Mar. Biol. Carnegie Inst. Washington*, vol. X, pp. 1-219, pls. 1-38.

1923 Echinoderms from Lower California with Descriptions of New Species, Supplementary Report. *Bull. Am. Mus. Nat. Hist.*, vol. XLVIII, art. VI, pp. 147-163.

DELLE CHIAJE, S.

1828 Memoire sulla storia e notomia degli animali senza Vertebre del regno di Napoli, vol. 3, pp. I-XX, 1-232, pls. 31-49.

DÖDERLEIN, L.

1911 Über Japanische und andere Euryalae. *Abh. Math.-Phys. Kl., K. Bayer. Akad. Wiss.*, Suppl. Bd. 11, Abh. 5, pp. 1-123, pls. 1-7, figs. 1-25.

FISHER, W. K.

1905 New Starfishes from Deep Water off California and Alaska. *Bull. Bureau Fish.*, 1904 (1905), vol. XXIV, pp. 291-320.

1906 Two New Starfishes from Monterey Bay, California. *Zool. Anz.*, Bd. XXX, no. 10, pp. 299-302.

1910 New Starfishes from the North Pacific. *Zool. Anz.*, Bd. XXXV, no. 18, pp. 568-574.

1911 Asteroidea of the North Pacific and Adjacent Waters. Part I. Phanerozonia and Spinulosa. *Bull. U. S. Nat. Mus.*, no. 76, pp. 1-407, pls. 1-122.

1928 Asteroidea of the North Pacific and Adjacent Waters. Part 2. Forcipulata (part). *Bull. U. S. Nat. Mus.*, no. 76, pp. 1-243, pls. 1-81.

1930 Asteroidea of the North Pacific and Adjacent Waters. Part 3. Forcipulata (concluded). *Bull. U. S. Nat. Mus.*, no. 76, pp. 1-349, pls. 1-93.

GRAY, J. E.

1841 A Synopsis of the Genera and Species of the Class Hypostoma. *Ann. Mag. Nat. Hist.*, 1840 (1841), vol. VI, pp. 175-184 and pp. 275-290.

1851 Descriptions of some new Genera and Species of Spatangidae in the British Museum. *Ann. Mag. Nat. Hist.*, ser. 2, vol. 7, pp. 130-134.

GRUBE, A. E.

1866 Einige neue Seesterne des hiesigen Zoologischen Museum. *Jahresber. d. schles. Ges. vaterl. Cultur*, 1865 (1866), pp. 59-60.

JACKSON, R. T.

1912 Phylogeny of the Echini, with a Revision of the Palaeozoic Species. *Mem. Boston Soc. Nat. Hist.*, vol. 7, pp. 1-491, pls. 1-66.

LECONTE, J. L.

1851 Zoological Notes. *Proc. Acad. Nat. Sci. Philadelphia*, vol. 5, pp. 316-319.

LUDWIG, H.

1905 Asteroidea in: Explorations of "Albatross" in Tropical Pacific, 1891 and 1899-1900. *Mem. Mus. Comp. Zool.*, vol. XXXII, no. 7, pp. 1-290, pls. 1-34, 1 map.

LÜTKEN, C. F.

1856 Bidrag til Kundskab om Ophiurerne ved Central-Amerikas Vestkyst. *Vid. Med. Dansk Nat. Foren.*, 1856, pp. 20-26.

1858 & 1859 Ophiuridarum, Additamenta ad historian; i-iii afdeling. Copenhagen, 1858, pp. 1-74, pl. 2; 1859, pp. 75-169, pl. 5.

1865 Kritiske Bemaerkninger om forskjellige Söstjerner (Asterider) med Beskrivelse af nogle nye Arter. *Vid. Med. Dansk Nat. Foren.*, 1864, pp. 123-169.

LÜTKEN, C. F. & MORTENSEN, T.

1899 Ophiuridae in: Exploration of "Albatross" in Eastern Tropical Pacific, 1891. *Mem. Mus. Comp. Zool.*, vol. XXII, no. 2, pp. 93-208, pls. 1-23.

LYMAN, T.

1860 Descriptions of New Ophiuridae belonging to the Smithsonian Institution and to the Museum of Comparative Zoology. *Proc. Boston Soc. Nat. Hist.*, vol. VII, pp. 193-205.

1865 Ophiuridae and Astrophytidae. *Ill. Catal. Mus. Comp. Zool.*, no. 1, pp. 1-197, pls. 1-2.

1875 Ophiuridae and Strophytidae of the "Hassler" Expedition. *Ill. Catal. Mus. Comp. Zool.*, no. VIII, pp. 1-34, pls. I-V.

MATSUMOTO, H.

1915 A new Classification of the Ophiuroidea: with Descriptions of New Genera and Species. *Proc. Acad. Nat. Sci. Philadelphia*, pp. 43-92.

MCCLENDON, J. F.

1909 The Ophiurans of the San Diego Region. *Univ. Cal. Pub. Zool.*, vol. 6, no. 3, pp. 33-64, pls. 1-6.

MORTENSEN, T.

1907 *The Danish Ingolf-Expedition*, vol. 4, Echinoidea, pt. 2, pp. 1-200, pls. 1-19.

1928 A Monograph of the Echinoidea. Copenhagen, vol. 1, pp. 1-547, pls. 1-88, 173 figs.

MÜLLER, J. & TROSCHEL, F. H.

1842 System der Asteriden, pp. I-XX, 1-135, pls. 1-12.

NIELSEN, E.

1932 Ophiurans from the Gulf of Panama, California and the Strait of Georgia. Papers from Dr. Th. Mortensen's Pacific Expedition, 1914-1916. LIX. *Vid. Med. Dansk Nat. Foren.*, Bd. 91, pp. 241-346, figs. 1-42.

SLADEN, W. P.

1889 Asteroidea in: Report on the Scientific Results of the Voyage of "H. M. S. Challenger," Pt. LI, *Zoology*. Vol. XXX, text, pp. 1-712, pls. 1-117.

STIMPSON, W.

1857 On the Crustacea and Echinodermata of the Pacific Shores of North America. *Boston Journ. Nat. Hist.*, vol. VI, art. XXVII, pp. 444-532, pls. XVIII-XXVIII.

VERRILL, A. E.

1867a Notes on the Echinoderms of Panama and the West Coast of America with descriptions of new genera and species. *Trans. Conn. Acad.*, vol. I, pt. 2, pp. 251-322.

1867b Distribution of the Echinoderms on the Pacific Coast of America. *Trans. Conn. Acad.*, vol. I, pt. 2, pp. 323-351.

1868 Notice of a Collection of Echinoderms from La Paz, Lower California. *Trans. Conn. Acad.*, vol. I, pt. 2, pp. 351-376, 1 pl.

1869 On new and imperfectly known Echinoderms and Corals. *Proc. Boston Soc. Nat. Hist.*, vol. 12, pp. 381-396.

1870 Descriptions of Echinoderms and Corals from the Gulf of California. *Amer. Journ. Sci.*, ser. 2, vol. 49, pp. 93-100.

1871a Observations on the Echinoderms from the Pacific Coast of America. *Trans. Conn. Acad.*, vol. I, pt. 2, pp. 568-593, pl. 10.

1871b Echinoderm Fauna of the Gulf of California and Cape San Lucas. *Trans. Conn. Acad.*, vol. I, pt. 2, pp. 593-596, pl. 10.

1899 North American Ophiuroidea. *Trans. Conn. Acad.*, vol. X, pt. 2, pp. 301-386, 2 pls.

XANTUS, J.

1860 Descriptions of Three New Species of Starfishes from Cape San Lucas. *Proc. Acad. Nat. Sci. Philadelphia*, p. 568.

16.

The Templeton Crocker Expedition. XI. Hermit Crabs from the Gulf of California and the West Coast of Lower California.[1]

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Research Associate in Crustacea, San Diego Society of Natural History

[Note: This is the eleventh of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

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Introduction.

This collection of pagurids from the Gulf of California comprises 26 species in 9 genera. 8 new species are described, and 5 new combinations are noted. New locality records are given, some extending the known range nearly 20 degrees of North latitude. The type specimens for all the new species are deposited in the New York Zoological Society.

I wish to express my thanks to Dr. Knud Stephensen, of the Zoologisk Museum, Copenhagen, and Dr. Bruno Parisi, of the Museo Civico di Storia Naturale, Milan, for literature, and to Dr. Waldo L. Schmitt, of the U. S. National Museum, for the loan of comparative specimens, and photographs of some unpublished drawings in that institution. I wish also to acknowledge my indebtedness to the California Academy of Sciences in San Francisco, for the loan of material.

Family Coenobitidae.

Genus *Coenobita* Latreille.

Coenobita compressus (Guérin).

Coenobita compressa Guérin. Voy. autour du Monde sur la *Coquille* par Duperrey, *Zool.*, vol. 2, pt. 2, 1831, p. 29.

Coenobita compressus Faxon. *Mem. Mus. Comp. Zool.*, vol. 18, 1895, p. 52; Rathbun, *Proc. U. S. Nat. Mus.*, vol. 38, 1910, p. 596; Schmitt, *Zoologica*: N. Y. Zool. Soc., vol. 5, no. 15, 1924, p. 170; Boone, *Zoologica*: N. Y. Zool. Soc., vol. 14, no. 1, 1931, p. 25, fig. 7.

General Range: East Africa to Pacific shores of America.

Local Distribution: A single male specimen was taken at San Lucas Bay, inside Cape San Lucas, Baja California, Mexico (Station 135).

Sex and Size: This male specimen has the following dimensions: length from rostrum to telson 57 mm., of carapace 17 mm., of precervical portion of carapace 9 mm., width 6 mm., length of cheliped 28 mm., of merus 9 mm., of carpus 7 mm., of manus 10.5 mm., of dactyl 6 mm., width of manus 9.5 mm., length of eye-stalk 5.0 mm.

Color: In alcohol, carapace a cream; chelipeds and ambulatories a taupe; hands a brownish-yellow.

Habitat: For the most part these terrestrial hermit crabs inhabit the land bordering on the sea. They select heavy shells for their abode. They are, in the main, vegetarians, though they do not limit their diet and may at times act as scavengers, or become carnivorous. In the author's experience, they seem to have a strongly developed sense of smell, as they immediately gathered in large numbers on fresh burro droppings. They also proved a nuisance to the mammalogist in our party, who baited his traps with rolled oats. In addition they are good tree climbers.

Remarks: This is a widely distributed and variable species. Its range does not extend to the head of the Gulf of California.

Family PAGURIDAE.

Genus *Paguristes* Dana.

Key to species of Paguristes *collected on this expedition.*

A. Hands broad, 1/5 longer than wide. Antennal flagellum reaching hand.
  B. Chelipeds without heavy spines except on inner margins; carpus with 3, manus with 6 or 7. Flagellum nearly naked. *P. digueti.*
  B′. Chelipeds with heavy spines on upper surface and inner margins; carpus with 6, manus with 4. Flagellum lightly ciliated. *P. bakeri.*
A′. Hands twice or nearly twice as long as wide. Antennal flagellum reaching hand. Chelipeds spinulose.
  B. Flagellum heavily ciliated beneath. Hands more than twice as long as wide. Inner margin of carpus with 4 spines; manus with 3 spines. *P. occator.*
    C. Hands twice as long as wide. Inner margin of carpus with 6 spines; manus with 5 spines. *P. praedator.*
  B′. Flagellum lightly ciliated. Inner margin of carpus with 5 spines; manus with 4 spines.
    C. Rostral tooth short, equal in length to laterals. Hands 2/3 as wide as long. *P. holmesi.*
    C′. Rostral tooth long, exceeding the length of laterals. Hands almost twice as long as wide. *P. oculiviolaceus.*
A″. Hands twice as long as wide. Antennal flagellum short, not reaching hand; lightly ciliated. Inner margin of carpus with 4 spines; manus with 3 spines. *P. aztatlanensis.*

Paguristes digueti Bouvier.

Paguristes digueti Bouvier. *Bull. Soc. Philom.*, Paris, vol. 8, no. 5, 1892-93, p. 18, figs. 1-4 (type-locality, Santa Rosalia, Baja California).

General Range: So far only recorded from the Gulf of California.

Local Distribution: A total of 5 specimens was taken from Arena Bank (Station 136), and Santa Inez Bay (Stations 141 and 143), between 7 and 33 fathoms.

The specimens were distributed as follows:

Station 136: D-5 (2 juvenile females); 33 fathoms.
Station 141: D-1 (1 male); 7 to 9 fathoms.
Station 143: D-1 (2 males); 29 fathoms.

Sex and Size: The collection numbers 3 adult males and 2 juvenile females. The largest specimen, a male from Station 141 D-1, has the follow-

ing measurements: length from rostrum to telson 80 mm., of carapace 20 mm., of precervical portion of carapace 11 mm., width of same 11 mm., length of cheliped 34 mm., of merus 10 mm., of carpus 7 mm., of manus 14 mm., of dactyl 10 mm., width of manus 11 mm., length of eye-stalk 9 mm.

Color: In alcohol, a pinkish-white, maculated with a rich red; hands a darker red. Cornea of eyes blue, on red stalks.

Habits, Habitat: This species usually occupies a shell with a narrow aperture, such as *Strombus*, which gives a distorted shape to the carapace, greatly distending the branchial regions. It is evidently not an inter-tidal form, but may be expected in depths ranging from 10 to 50 fathoms.

Remarks: These are new locality records for this species, extending the geographical range more than 4 degrees of latitude to the south.

Paguristes bakeri Holmes.

Paguristes bakeri Holmes. *Occas. Papers Calif. Acad. Sci.*, vol. 7, 1900, p. 152 (type-locality, San Diego, California); Rathbun, *Harriman Alaska Expedition*, vol. 10, 1910, p. 162; Hilton, *Jour. Ent. Zool.*, Pomona Coll., vol. 8, no. 2, 1916, p. 65, figs. 11-12; Schmitt, *Univ. Cal. Pub. Zool.*, vol. 23, 1921, p. 124, pl. 18, figs. 2-6.

General Range: From San Francisco to San Diego, California, and the Gulf of California, to a depth of 116 fathoms. (Schmitt).

Local Distribution: A total of 7 specimens was taken east of Cedros Island (Station 128 D-1), at 39 fathoms; 1 male was taken east of Cedros Island (Station 126 D-3), at 40 fathoms.

Sex and Size: The series collected at both stations consists of 7 males and 1 female, all adults. A large male from Station 128 has the following measurements: length from rostrum to telson 90 mm., of carapace 26 mm., of precervical portion of carapace 14 mm., width of same 12 mm., length of cheliped 45 mm., of merus 14 mm., of carpus 12 mm., of manus 17 mm., of dactyl 9 mm., width of dactyl 13.5 mm., length of eye-stalk 11 mm.

Color: In alcohol, carapace a pinkish-white overlaid with an orange red. Eye-stalks red. Chelipeds and ambulatories a buff. Spines a corneous brown. Setae a straw yellow.

Habits, Habitat: This large, active pagurid occupies a heavy shell. In the shallower waters along the California coast it usually occupies the discarded shell of *Polinices lewisii* (Gould), or some such durable gastropod shell. When occuping the *Polinices* shell it is invariably accompanied by a polynoid worm, which seeks seclusion in the umbilicus.

Remarks: These more southern forms differ in no wise from those taken in more northern waters, and are similar in form, color and size, to those found off the California coast.

Paguristes occator, sp. nov.

Type: Male, holotype; Cat. No. 361,119, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 2; from the Gulf of California, 23° 01′ N. Lat., 109° 28′ W. Long., off Gorda Point, Lower California, Mexico; 75 fathoms; bottom sandy; April 21, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Median tooth extending past laterals and past the proximal end of eye-scales. Eye-stalks long, slender, and slightly curved outward. Chelipeds spinulose, margins subparallel; width and thickness of hands subequal. Flagellum of antennae heavily ciliated beneath, nearly nude on upper surface.

Description: Anterior portion of carapace slightly longer than wide; rostral tooth triangular, equilateral, sharp-pointed, extending past laterals and between the bases of the eye-stalks; laterals obtuse, armed with a minute, marginal spinule; surface punctate, with a few tufts of setae.

Eye-stalks long, slender and slightly curved outward; in length they equal the width of the carapace, and extend nearly as far as the distal end of the merus. Ophthalmic scales broad at base, inner margin entire, curving downward, tip triangular, trifid, with a prominent, conical spine, two lesser spines on outer margin.

Antennal acicle extends 3/5 the length of the eye-stalk; including spines, it is 1½ times longer than wide; six prominent, sharp, corneous-tipped spines on inner margin; two similar spines on outer distal margin, with basal margins of spines supporting tufts of long, pinnate-tipped setae. Distal end of 3rd peduncle of antennae does not reach cornea of eye; flagellum, heavy ciliated on under side, sparsely on upper surface, reaches past proximal end of hands.

The chelipeds are subequal, similar, spinulose, with tufts of pinnate-tipped setae originating at the anterior base of spines; merus trigonal, upper edge granular, distal and subdistal margins armed with a lateral row of spines; lower margins spinulose, the outer with short, the inner with 6 or 7 longer and more prominent spines increasing in length and size, distally; the carpus is short, ¼ longer than wide, armed on inner margin with 4 upward- and forward-pointing corneous spines inside of which, on upper surface, is a row of smaller intermediate spines, while outer margin has a row of small spines; hands are long, narrow and thick, subequal, similar; width, subequal to thickness; 3 long, corneous-tipped spines on inner margin of palm; row of spines on outer margin of hand, the largest on pollex; few scattered similar spines on upper surface of hand and fingers; dactyl is subequal in length to carpus; pollices subequal in width to their dactyli, with tips corneous, acuminate; teeth are calcareous lobes.

The ambulatory legs slightly exceed the chelipeds in length, margined with setae; upper carpal and propodal crest of 1st pair, spinulose, of 2nd pair, rugose.

Color: In alcohol, a light pinkish tint, iridescent. Chelipeds splotched with pink and white. Dactyli of ambulatory legs banded with white. Setae a straw yellow.

Measurements: Male, holotype; length from rostrum to telson 36 mm., of anterior portion of carapace 6 mm., width 5 mm., length of cheliped 14.8 mm., of merus 5.7 mm., of carpus 4 mm., of manus 7 mm., of dactyl 4 mm., thickness of hand 3 mm., width 3 mm., length of eye-stalk 5 mm., of antennal acicle 2.5 mm., width 1 mm.

Range: Known only from type locality.

Material Examined: The holotype male (see *Type*).

Remarks: This proposed species is allied to *P. turgidus* (Stimpson), 1857, but differs in that the hands are twice as long as wide, instead of one-third, or more, longer than wide, by the eye-stalks being as long as the width of the carapace, instead of three-fourths as long as the width of the carapace, by the antennal flagellum being densely ciliated below, instead of sparsely haired, by the inner margin of the hand being armed with 3 spines, instead of armed with 4. It is also allied to *P. ulreyi* Schmitt, 1921, but differs in the shape and size of the hand, being straighter and narrower, and by there being fewer spines on the chelipeds.

Paguristes praedator, sp. nov.

Type: Male, holotype; Cat. No. 36,782, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 27; from the Gulf

of California, 23° 28′ N. Lat., 109° 24′ W. Long., 3 miles northeast of Cape Pulmo, Lower California, Mexico; 50 fathoms; bottom sandy with rock; May 1, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Median tooth of carapace not extending past laterals, nor reaching base of eye-scales. Eye-stalks long, slender, straight. Chelipeds spined on inner margin; carpus with 6; manus with 5. Antennal flagellum heavily ciliated beneath.

Description: Anterior portion of carapace but slightly longer than wide, surface with few setae; median tooth subtruncate, short, not extending to the base of eye-scales, upper surface concave; lateral projections obtuse, extending past the median and tipped with a small marginal spine. The posterior margin of the carapace is but slightly concave.

Eye-stalks long, slender, slightly constricted in the middle, in length they are subequal to the length of the carpus or the dactyl of the chelipeds. Ophthalmic scales long, narrow, pointed, margins entire.

Antennal acicle nearly straight, with two spines on the inner margin, one median, the other subproximal; as a variation there may be three spines. The acicle does not reach the cornea of the eye. The 3rd peduncle of the antennae reaches past the eye by nearly 1/3 its length, while that of the antennule exceeds the eye by ½ its length.

The chelipeds are subequal, similar, with tufts of setae; merus trigonal, with an upper crest of setae, the upper distal end and the subdistal margin are each armed with a single tooth, the inner lower margin spinulose, the outer granulose; the carpus in a lateral cross-section forms a quadrant, with the upper face rounding from the inner margin to the lower outer margin, the inner margin is armed with 6 spines, the anterior the largest, the outer margin is armed with 4 or 5 much smaller teeth, the surface between these ridges is smooth, the outer lower distal end, or hinge joint of the hand is spinulose; the hand is twice as long as wide and slightly more than a third its length in thickness, a lateral cross-section forming a quadrant, the inner margin of the palm is armed with 5 upward- and inward-pointing teeth, the outer margin of the hand is armed with small pointed tubercles, more numerous and larger on the pollex, the upper surface of the hand has 3 longitudinal rows of small, bristle-bearing tubercles, the crest of the dactyl is spinulose as is its upper surface, the fingers gape from base to corneous apices, and are armed with small calcareous denticules, the bases of the spines and spinules are setaceous.

The ambulatory legs are slender, the length of the dactyli slightly exceeding their propodi, the 1st pair are crested with spines on the carpus and propodus, the 2nd pair with a spinule on the upper distal end of the carpus only, both legs are margined with setae.

The distal margin of the telson is smooth, unarmed.

Color: In alcohol, the ground color is an iridescent cream with dashes and splotches of crimson, this extends to the chelipeds and legs, the former are more highly colored on the inside, while the latter appear to be banded. The setae are a straw colored yellow.

Measurements: Male holotype; length from rostrum to telson 27 mm., of anterior portion of carapace 3.5 mm., width 3.4 mm., length of cheliped 12 mm., of merus 3.8 mm., of carpus 3 mm., of hand 5 mm., of dactyl 3 mm., width of hand 2.3 mm., thickness 1.8 mm., length of eye-stalk 3.1 mm.

Range: So far only known from the Gulf of California.

Material Examined: A series of 85 specimens of both sexes from Arena Bank off Punta Arena, Lower California, Mexico (Station 136); the types were selected from this series which were collected in April and May of 1936, in from 30 to 85 fathoms. A series of 16 specimens of both sexes was

taken from Santa Inez Bay, Lower California, Mexico (Station 142, Dredge 3); April 11, 1936; in 40 fathoms. A male specimen from Gorda Bank, off Gorda Point, Lower California, Mexico (Station 150, Dredge 3); in 58 fathoms; April 21, 1936.

Remarks: This proposed species is allied to *P. sayi* A. M. Edwards and Bouvier, 1893, in that the antennal peduncles in both species exceed the eye; they differ in that the eye-stalks in *P. sayi* are short and heavy, while in this proposed species they are long and slender. This species also somewhat resembles the Indo-Pacific species *P. incomitatus* Alcock, 1905, in the shape of the chelipeds and the number of spines on the margin of the hand, and that the fingers do not close; it differs in that the antennae are long, instead of short.

Paguristes holmesi, sp. nov.

Type: Male, holotype; Cat. No. 36,1120, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 2; from the Gulf of California, 23° 01′ N. Lat., 109° 28′ W. Long., off Gorda Point, Lower California, Mexico; 75 fathoms; bottom sandy; April 21, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Rostral tooth equal in length to laterals, just reaching bases of eye-scales. Chelipeds setaceous, spinose; hands more than 2/3 longer than wide; carpus with 5 marginal spines; hand with 4.

Description: Anterior portion of carapace longer than wide; front tridentate, rostral tooth triangular, not sharp, reaching to base of eye-scales; laterals obtuse, armed with a sharp marginal spine; rostral tooth subequal in length to laterals.

Eye-stalks long, slender, straight, not quite twice as long as the distance between the lateral spines of the carapace. Ophthalmic scales toothed on inner and outer margins, about 8 teeth in all. Third peduncle of antennule extends past cornea of eye about 1/5 its length.

Antennal acicle reaches 5/6 the length of the eye-stalk, is nearly straight and armed on both margins with spines, 3 on the proximal inner end, and 3 on the distal outer margin.

The chelipeds are subequal, similar, hairy and spinulose; merus spined on upper distal margin, behind which the subdistal margin is also spined, behind this latter margin are 2 or 3 smaller, lateral rows of spines, the inner and outer borders of the lower face are spinulose and tuberculate; carpus with 5 stout spines on upper inner edge, its upper surface, as is the hand, covered with upstanding, corneous-tipped spines, from the anterior bases of which are tufts of long yellow setae; the hands are widest at the base of the dactyli, about 2/3 as wide as long; inner edge of palm armed with 4 stout spines, with 3 much smaller ones below on inner face, and intermediate between them; the length of the dactyl equals the length of the palm, is spinulose like the upper surface of the palm and pollex, and is armed on its distal prehensile edge with a corneous, close set row of teeth, the median and proximal teeth are calcareous, as are those of the pollex, except for the corneous tip.

The ambulatory legs extend past the chelipeds by the length of their dactyli; the dactyli of the right side being slightly longer than those of the left; the carpus and propodus of the 1st pair of legs are crested with a row of stout spines; minute spines may or may not occur on the carpus of the 2nd legs, both pairs of legs and their dactyli are lined with tufts of yellow setae similar to that of the chelipeds.

Color: In alcohol, a light pinkish tint. Hands pinkish, flecked with red. Ambulatory legs iridescent on smooth surfaces; dactyli flecked with red. Eye-stalks white on upper surface, carmine on sides and beneath.

Measurements: Holotype, male; length from rostrum to telson 49 mm., of carapace 17 mm., of anterior portion of carapace 9.5 mm., width 8 mm., length of cheliped 25 mm., of hand 10.8 mm., width of hand 6.2 mm., length of dactyl 6.2 mm., of eye-stalk 6.8 mm., distance between laterals 3.8 mm., length of antennal flagellum 14.5 mm. An imperfect male paratype which is larger than the holotype has the following measurements: length from rostrum to telson 59 mm., of anterior portion of carapace 10.7 mm., width 9.8 mm., length of eye-stalk measured from base to tip of cornea 7.8 mm. In this specimen the rostral projection falls behind the laterals.

Range: Lower portion of the Gulf of California.

Material Examined: A series of 39 specimens, 27 males and 12 females, from Gorda Bank (Station 150), off Gorda Point, Lower California, Mexico; in from 50 to 85 fathoms; April 22 to May 3, 1936; the types were selected from this series. One male from Arena Bank (Station 136), Gulf of California, off Cape Pulmo, Lower California, and one male from Station 126, Dredge 1; from east of Cedros Island, west side of Lower California, in 28° 07′ N. Lat., 115° 09′ W. Long.; in 38 fathoms; March 27, 1936.

Remarks: This proposed species is allied to *P. ulreyi* Schmitt, 1921, but differs in that the antennae are not thickly haired, instead of being thickly haired underneath; by having 4 spines on the inner margin of the palm and 3 smaller ones below these, instead of having 3 spines on the margin with 2 beneath; by the ophthalmic scales being spinulose on both margins, instead of with 4 or 5 spines at the tip. This proposed species also closely resembles *P. bakeri* Holmes, 1900, in the size, shape, coloration and general disposition of the spines on the chelipeds, but differs in the contour of the hands, those of *P. bakeri* being much the wider of the two species.

This species is named for Dr. Samuel J. Holmes, of the University of California, in appreciation of his work in crustacea, and for the favors he has granted me.

Paguristes oculiviolaceus, sp. nov.

Type: Male, holotype; Cat. No. 36,796, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 3; from Gorda Bank, Gulf of California, 23° 00′ N. Lat., 109° 28′ W. Long., off Gorda Point, Lower California, Mexico; 58 fathoms; bottom sandy; April 21, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Median tooth extending past laterals, reaching well between the eye-scales, equilateral. Eye-stalks long, straight, slightly ciliated at cornea, violet colored. Chelipeds with heaviest spines on inner margins, 5 on carpus, 4 on manus. Antennal flagellum lightly ciliated.

Description: Anterior portion of carapace longer than wide, seminude; median tooth equilateral, extending past the laterals and well between the eye-scales; laterals obtuse, armed with a marginal spinule. The posterior margin of the carapace with a median concavity.

Eye-stalks long, straight, slightly dilated at the cornea, subequal in length to that of the dactyl of the chelipeds, and extends to the subdistal margin of the merus. Ophthalmic scales wide at base, with bifid tips; inner margin entire.

Antennal acicle nearly straight, armed on inner margin with 4 sharp teeth, outer margin with 1, tip bifid, it extends but little past half the length of the eye. The 3rd peduncle of the antennae reaches 2/3 the length of the eye, while that of the antennule reaches half its length past the eye. The antennal flagellum is sparsely ciliated and reaches the proximal end of the hand.

The chelipeds are subequal, similar, with tufts of setae; merus trigonal,

subequal in length to the width of the carapace, with a thin crest of setae, distal and subdistal margins armed with a few spines, lower inner margin with a few spines, the outer with setae and spinules; the carpus is armed on its inner margin with a row of 5 upward- and forward-pointing, corneous-tipped spines, a row of smaller similar spines parallel the marginal spines, the outer margin is outlined with still smaller spines, below which, on the outer surface, is a row of still lesser spinules, the anterior bases of the spines are tufted with short setae; the hand is spinulose on its upper surface, and rounded down to its outer margin, it is subequal in length to the length of the anterior portion of the carapace, the inner margin of the palm is armed with 4 teeth, similar to those on the carpus, the proximal two having a common base, the distal two are entire and separate, the outer margin, like the surface of the hand and fingers, is roughened with small setaceous spinules, the pollex is wider than the dactyl, corneous-tipped, the fingers gape evenly from base to corneous, spoon-shaped apices.

The ambulatory legs are slender, crested with short setae, and exceed the length of the chelipeds by half their dactyli; the dactyli being nearly as long as their carpus and propodus combined; the carpus and propodus of the first pair are crested with spines, those of the second pair are lightly rugose.

The distal margin of the telson is margined with corneous-tipped spines.

Color: In alcohol, the carapace and legs are buff with pinkish iridescence, the inner side of the merus of the chelipeds is a dull orange. The remarkable feature is the brilliant violet color of the eye peduncles and the antennules. The setae are a straw color.

Measurements: Male holotype; length from rostrum to telson 31 mm., of anterior portion of carapace 5.3 mm., width 4.5 mm., length of cheliped 13 mm., of merus 4.5 mm., of carpus 2.9 mm., of hand 5.5 mm., of dactyl 3.5 mm., width of hand 3 mm., thickness 2 mm., length of eye-stalk 3.5 mm.

Material Examined: The male holotype and the male paratype from the type locality.

Remarks: This proposed species is allied to *P. lymani* Milne Edwards and Bouvier, 1893, which it somewhat resembles in the number and disposition, but not in the shape, of the spines on the chelipeds. It differs also in the following respects: rostrum exceeding laterals, instead of not being so far advanced; eye-scales slender to the bifid tip, instead of stout; terminal margin of telson with a few well separated teeth, instead of with many close-set teeth. The shape of the chelipeds also somewhat resembles those of *P. puniceus* Henderson, 1896, an Indo-Pacific species.

Paguristes aztatlanensis, sp. nov.

Type: Female, holotype; Cat. No. 36,788, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 27; from the Gulf of California, 23° 28′ N. Lat., 109° 24′ W. Long., 3 miles northeast of Cape Pulmo, Lower California, Mexico; 50 fathoms; sandy bottom with rock; April 30, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Rostral tooth long, sharp, triangular, slightly exceeding laterals, extending between bases of eye-scales. Eye-stalks extending past merus. Flagellum short, lightly ciliated. Chelipeds densely spinulose, pubescent; carpus with 4 inner-marginal spines; palm of hand with 3; tips of fingers spooned.

Description: Anterior portion of carapace nearly 1/3 longer than wide, the width subequal to the length of the hands, with a few setae, rugose, and a few spinules on lateral regions. Median tooth forms an acute triangular rostrum, slightly exceeding the laterals, which are obtuse and armed with a

small marginal spine; between the median spine and the laterals the margin is concave and thickened. The gastric lobes are well defined anteriorly.

Eye-stalks straight, cylindrical, subequal in length to that of the merus, and extending past that member by nearly half their length. The ophthalmic scales are subquadrate at their base, with short equilateral apices, armed at the tip with one or more apical spines. The distal end of the antennular peduncle just exceeds the tip of the eye.

The antennal acicle is slender, short, extending but half the length of the eye-stalk, bifid at the tip, armed with 3 well-formed spines on inner margin, with 2 on the outer distal margin, and is lightly setose; the segment behind the base of the acicle has one or more well developed spines, its distal outer terminus is bifid, the outer margin spinulose. The distal end of the 3rd peduncle is but little advanced beyond the acicle. The flagellum is short, lightly ciliated and subequal in length to that of the merus.

The chelipeds are short, subsimilar, equal, the carpus and manus covered with short, black-tipped spines, the largest on the inner margins, these spines are nearly covered with pubescence, growing less thick at the base of the fingers; the merus is trigonal, smooth on the inner side, rugose on the outer, armed on the distal and subdistal margin with a few spines, the lower inner margin with spine-tipped tubercules; the carpus has 4 inner-marginal spines and a row of 5 smaller spines on the outer margin, and a prominent spine over the upper articulation with the hand; the hands are rounded over from the inner margin, which is armed with 3 spines, the surface having many short, sharp-tipped spines visible through the pubescence, the length of the dactyl is subequal to the width of the hand, its thickness is 2/3 its width, the fingers meet on the upper surface and are excavated beneath, with corneous semi-spoon-shaped tips.

The ambulatory legs are stout, setose and pubescent on their margins, and extend past the chelipeds by the length of their dactyli, the carpus, propodus and dactyls have numerous rows of small corneous-tipped spines. The rasps of the 3rd and 4th legs and also those of the uropods are composed of short, dark, corneous spinules. The terminal margin of the telson is armed with wide-spaced teeth.

Variation: Of the two female specimens taken, one, the holotype, had occupied a shell with a circular aperture, while its companion, a non-ovigerous female, had occupied a shell with a wide narrow slit, similar to that of a *Conus*. This opening vertically constricted the animal's carapace and distorted its appearance, as is the carapace of *P. digueti* Bouvier, 1892, which occupies the shell of a *Strombus*.

Color: In alcohol, a pinkish tint on an ivory ground.

Measurements: Female holotype; length from rostrum to telson 34 mm., of anterior portion of carapace 9 mm., width 5.3 mm., length of cheliped 16 mm., of merus 4.5 mm., of carpus 4 mm., of hand 5.5 mm., width of hand 3 mm., thickness 2 mm., length of eye-stalk 4.3 mm., length of flagellum of antennae 4.6 mm.

Range: Known only from type locality.

Material Examined: Two female specimens from the same dredge haul, the holotype the larger of the two.

Remarks: This proposed species is closely allied to *P. fecundus* Faxon, 1893, but differs in that the terminal lobes of the telson are distinctly toothed on their margins, instead of obscurely toothed, by the antennal acicle reaching 2/3 the distance of the eye peduncle, instead of nearly to the end of the peduncle, by the ischium of the outer maxillipeds being armed on their inner margins with a serrate row of short teeth, the merus is unarmed, instead of armed with 3 or 4 denticles on the lower margin of the merus.

Aztatlan is a name for the prehistoric Mexican frontier on the Pacific coast.

Genus *Petrochirus* Stimpson.

Petrochirus californiensis Bouvier.

Petrochirus californiensis Bouvier. *Bull. Mus. d'Hist. Nat. Paris,* no. 1, 1895, p. 6 (type-locality, not given; Lower California); Nobili, *Boll. Mus. Zool. Anat. comp. R. Univ. Torino,* vol. 16, no. 415, 1901, p. 24.

General Range: Gulf of California to Ecuador. (Nobili).

Local Distribution: A single male specimen from Monument Beach, Santa Inez Bay, Baja California, Mexico; collected April 12, 1936.

Sex and Size: A male specimen with the following measurements: (the first figures given are for the specimen collected by this expedition; the second figures are for those of a normally large male collected by the author at Punta Penasco, Sonora, Mexico; May 3, 1935) length from rostrum to telson 98 mm.-128 mm., of carapace 29 mm.-38 mm., of precervical portion of carapace 12.6 mm.-17 mm., width of same 13.5 mm.-18 mm., length of major cheliped 62 mm.-74 mm., of merus 14 mm.-20 mm., of carpus 15 mm.-20 mm., of manus 28 mm.-38 mm., of dactyl 15 mm.-21 mm., width of manus 12 mm.-18 mm., thickness of manus 11 mm.-17.5 mm., length of eye-stalks 12.6 mm.-17 mm.

Color in Alcohol: A bluish-red. Chelipeds and ambulatories with blood-red maculations on inner and outer distal ends of meri; fingers of chelipeds white. Eye-stalks a taupe, with a deep red, inverted, V-shaped marking at distal upper end. Antennal flagellum banded red and white. Setae on dactyli of walking legs a red brown.

Habits, Habitat: This large pagurid is somewhat sluggish in its movements. Most of the specimens collected in the inter-tidal zone, in the Gulf of California, were occupying the shell of *Phyllonotus nigritus* (Philippi), and were accompanied by a polynoid worm and commensal porcellanids.

Remarks: This is the first record of the finding of this common and conspicuous crab in the waters where it was first discovered by Diguet, since Bouvier wrote its all too brief description.

Genus *Dardanus* Paulson.

Dardanus sinistripes (Stimpson).

Pagurus sinistripes Stimpson. *Ann. Lyc. Nat. Hist.,* N. Y., vol. 7, 1859, p. 82 (type-locality, Panama); Bouvier, *Bull. Mus. d'Hist. Nat. Paris,* no. 1, 1895, p. 8; Nobili, *Boll. Mus. Zool. Anat. comp. R. Univ. Torino,* vol. 16, no. 415, 1901, p. 23 (Ecuador).

Dardanus sinistripes (Stimpson). Rathbun, *Proc. U. S. Nat. Mus.,* vol. 38, 1910, p. 556, pl. 49, fig. 2, and p. 597; Schmitt, *Proc. Calif. Acad. Sci.,* vol. 13, no. 24, p. 382.

General Range: From the Gulf of California to Peru (Rathbun).

Local Distribution: A total of 27 specimens was taken off Arena Bank (Station 136); 14 adults and several juveniles were taken in Santa Inez Bay (Stations 141, 142 and 143 respectively); 2 specimens were taken off Gorda Bank (Station 150 D-3). All of the above specimens were dredged in depths ranging from 10 to 60 fathoms. In addition to these specimens, a larval form was taken (Cat. No. 36,784) from off Arena Bank (Station 136).

Sex and Size: The entire series taken at the above stations is composed of 20 males, 23 females and 2 juveniles, and ranges in size from the first adult form to the largest yet to be recorded. The largest specimen, a male, has the following dimensions: length from rostrum to telson 110 mm., of

carapace 28 mm., of precervical portion 15 mm., width of same 14 mm., length of major cheliped 62 mm., of merus 14 mm., of carpus 13 mm., of manus 27 mm., width of manus 18 mm., length of eye-stalk 10 mm.

Color: In alcohol, the carapace is buff with red markings. The chelipeds, purple and red, with the interior margins of the meri white; the teeth of the fingers white, bordered with yellow. The ambulatory legs are purple, their dactyli with dark brown setae, their meri and carpi blotched on a light ground with red.

Habits, Habitat: The majority of the species of the genus *Dardanus* are inhabitants of the Indo-Pacific region, but 3 species are recorded from the Pacific coasts of North and South America. *D. sinistripes* is not an inter-tidal form, so far as the records show, but occupies the zone between 10 and 60 fathoms. It occupies any sort of shell from those having a large round opening to those with a narrow aperture, such as *Conus*.

Remarks: In the collection here assembled is a specimen of *Glaucothöe* H. M. Edwards, 1830, (Cat. No. 36,784) from off Arena Bank (Station 136).

Bouvier has ably pointed out that the genus *Glaucothöe*, is simply the larval stage of a pagurid, being without sex, and as such I regard it, and believe it is entitled to neither individual generic nor specific standing.

This specimen of larval form, or "*Glaucothöe*," I refer without hesitation to the genus *Dardanus*, and believe it to be the last larval stage of *Dardanus sinistripes* (Stimpson). In arriving at this conclusion, I have compared the larva with a series of juvenile specimens from this and other collections of *D. sinistripes*, among which were several specimens that exhibited the first adult form, in which the chelipeds are still quite similar, the abdomen still well segmented, though not calcareous or chitonous, the telson still much longer in proportion than that of the mature form. In comparing the larva with these juveniles, the following similarities of form become apparent: the eyes are similar in shape and size; the hands are similar in size, the fingers opening in the same plane; the 4th and 5th legs are similar, namely, subchelate and chelate; in both the abdomen is clearly segmented, though in the juvenile it is slightly coiled and not straight as in the larva; the telsons of both are long and subsimilar in shape.

Genus *Calcinus* Dana.

Calcinus californiensis Bouvier.

Calcinus californiensis Bouvier. *Bull. Mus. d'Hist. Nat. Paris*, no. 8, 1898, p. 380 (type-locality, San Jose Island, Gulf of California).

General Range: Gulf of California. Acapulco, Mexico.

Local Distribution: A total of 13 specimens (Cat. No. 36,815) was taken off Arena Bank (Station 136) in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms.

Sex and Size: The series consists of 6 males and 7 females. The largest specimen, a male, has the following dimensions: length from rostrum to telson 25 mm., of carapace 8 mm., of precervical portion of carapace 4.2 mm., width of same 3.6 mm., length of major cheliped 14.5 mm., of merus 3.3 mm., of carpus 3 mm., of manus 6 mm., of dactyl 3.5 mm., width of manus 4 mm., length of eye-stalk 3.8 mm.

Color in Alcohol: Reddish with white spots showing through on carapace. Chelipeds a dark brown with small bluish spots; carpus and manus margined with red. Ambulatory legs and dactyli red. Tips of fingers white.

Habits, Habitat: This inter-tidal species occupies the lower half of the tidal zone, where it is very plentiful throughout its range. An active, gregarious little animal, utilizing any of the smaller shells for an abode.

Remarks: This is the first record of *C. californiensis* having been taken since Diguet's two specimens were described by Bouvier. Bouvier remarked that this species is closely allied to *C. obscurus* Stimpson, 1859, and like myself, had none of the latter species with which to compare his specimens. As a means of quick identification, I would say that this species, *C. californiensis*, may be distinguished from *C. obscurus* by the solid color of the ambulatory dactyli, as in the latter species the dactyli are banded.

Genus *Pylopagurus* M. Edw. and Bouvier.

Pylopagurus varians (Benedict), new combination.

Eupagurus varians Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 24 (type-locality, Gulf of California); Bouvier, *Bull. Mus. Hist. Nat. Paris*, no. 8, 1898, p. 382.

General Range: So far only recorded from the Gulf of California.

Local Distribution: Two specimens, one from Arena Bank (Station 136 D-24), the other from Santa Inez Bay (Station 143 D-5), with a depth range of from 18 to 50 fathoms.

Sex and Size: Both specimens were males; the largest, from Santa Inez Bay, has the following measurements: length from rostrum to telson 34 mm., of carapace 8.3 mm. (carapace with a deep V-shaped notch in posterior margin), of precervical portion of carapace 5 mm., width of same 4.8 mm., length of major cheliped 38.4 mm., of merus 6.2 mm., of carpus 9 mm., of manus 13 mm., of dactyl 8.2 mm., width of manus 6.6 mm., length of eye-stalk 4 mm.

Color in Alcohol: Carapace a cream with a few red spots near cervical groove. Chelipeds a pinkish-buff, with deep red spots. Ambulatory legs banded with white and a yellow-red.

Habits, Habitat: This hermit crab is one of the few that does not have to change its abode as it grows larger, for the original shell which it occupies becomes incrusted with a bryozoan growth, which the crab is able to control at the aperture by using its large hand as an operculum; thus the aperture of the shell is always smooth, while the rest of the shell takes on varied and weird shapes. Not an inter-tidal form.

Remarks: It seems remarkable that Bouvier, who was the co-author of the genus *Pylopagurus*, retained Benedict's genus *Eupagurus* for this species, when he recorded Diguet's collection in 1898. The lack of a figure for this species is confusing.

Pylopagurus cervicornis (Benedict), new combination.

Eupagurus cervicornis Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 25 (type-locality, Gulf of California).

General Range: The Gulf of California.

Local Distribution: A total of 21 adult specimens and 2 juveniles was taken on Arena Bank (Station 136) in different dredges, in from 30 to 50 fathoms.

Sex and Size: This series consists of 19 males, 2 of them juvenile, and 4 females, none of them very large. The largest male in this series has the following dimensions: length from rostrum to telson 22 mm., of carapace 6 mm. (carapace with a deep V-shaped notch in posterior margin), of precervical portion of carapace 3.6 mm., width of same 3.2 mm., length of major cheliped 23.2 mm., of merus 3.6 mm., of carpus 5 mm., of manus 7.6 mm., of dactyl 5 mm., width of hand 5 mm., length of eye-stalk 3 mm.

Color in Alcohol: Carapace a cream with a few spots of red near the cervical groove on the calcified portion. Chelipeds a pinkish-buff, with deep red spots. Ambulatory legs banded with white and a yellow-red.

Habits, Habitat: This species occupies the same sort of abode as that of *P. varians*. One small specimen (Cat. No. 36,361) occupied a hole in a small sponge.

Remarks: These two species, *P. varians* and *P. cervicornis*, may prove to be one and the same species, one a variety of the other, when it is possible to get a large series of adult forms, from both ends of the Gulf of California, together for comparison. There seems to be an intergradation which is difficult otherwise to explain.

Pylopagurus coronatus (Benedict), new combination.

Eupagurus coronatus Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 24 (type-locality, Gulf of California).

General Range: Gulf of California.

Local Distribution: A single specimen was taken on Arena Bank (Station 136 D-24), in 50 fathoms.

Sex and Size: A male specimen with the following dimensions: length from rostrum to telson 15 mm., of carapace 4.5 mm., of precervical portion of carapace 3 mm., width of same 2.8 mm., length of major cheliped 11.4 mm., of merus 2.4 mm., of carpus 3 mm., of manus 5 mm., of dactyl 3.5 mm., width of manus 3.5 mm., length of eye-stalk 2.7 mm.

Color in Alcohol: Carapace, chelipeds and ambulatory legs have a whitish ground color, on which, in various patterns, is laid an orange-yellow and red. The pattern is sharp cut, distinctive, irregular, unblended.

Habitat: Little is known of the habits of this pagurid, as all specimens so far examined have been removed from their shell. It is not a shore form, but may be expected in depths of from 25 to 100 fathoms, within its range.

Remarks: This record, like several others, is the first, since the species was described nearly 45 years ago. From its scarcity in this and other dredgings examined, it appears to be a rare form.

Pylopagurus guatemoci, sp. nov.

Type: Male, holotype; Cat. No. 36,801, Department of Tropical Research of the New York Zoological Society; Station 175, Dredge 1; from location 5 miles west of San Jose Point, Pacific side of Baja California, 31° 25′ N. Lat., 116° 42′ W. Long., 45 fathoms; bottom shaley; May 24, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Calcified portion of carapace as broad as long, transversely convex, naked, polished, projections subequal. Major hand margined with large teeth, becoming smaller distally; minor hand heavily toothed on outer margin. Eyes long, slightly constricted in middle, cornea dilated.

Description: Anterior portion of carapace as broad as long, transversely convex, naked, polished; median projection obtuse, depressed, not extending past base of eye-scales, nor past the spinule-tipped, obtuse, lateral projections.

The eye-stalks are cylindrical, slightly constricted in the middle, and subequal in length to the merus of the major chela. The ophthalmic scales have broad bases and triangular apices, with margins entire; the subterminal spine is long, sharp, stout, and is situated just inside the point of

the scale. The distal end of the second peduncle of the antennule reaches the cornea.

The antennal acicle is slight, sharp-pointed, unarmed, except for a few hairs, and extends to the cornea of the eye. The third antennal peduncle extends half its length past the eye. The flagellum extends to the base of the major dactyl and is ciliated with occasional long and short hairs.

The chelipeds, as in the genus, are dissimilar and unequal. In the major cheliped the merus is trigonal, crested with a few short hairs; the distal lower tip of the ischium extends nearly to the distal lower margin of the merus; the carpus is widened distally, is subequal in length to the width of the carapace, is armed on its inner margin with two large, well formed teeth, one over the hinge of the hand, the other median, these are separated by a wide sinus, the median tooth is supported posteriorly by a ridge, there is no outer margin as the surface arches from the inner border to the lower outer margin, a few setae in tufts of three or four are on this surface, on the under surface the carpus is very narrow, almost a bridge, and deeply excavated on its forward surface for the reception of the hand; the hand, on its operculiform portion, is 4/5 as wide as long, the toothed proximal border is nearly straight, the rim of teeth is uneven in size, some teeth are double, others single with their tips bent inward, these tips are corneous spinules, the distal teeth of the dactyl and pollex are much smaller and more uniform than those of the palm; the excavated surface of the hand is microscopically set with minute corneous spine-tipped granules; the fingers are crossed at their corneous tips, joined on their upper surfaces and excavated beneath, armed on their cutting edges with calcareous lobes, the under side of the hand has a few scattered setae; the minor hand extends to the base of the major dactyl; the carpus is bicristate, with the spines of the outer margin more prominent; the hand is flattened on its upper surface, twice as long as wide, with a median row of spines to the gape, the outer margin with a raised crest of spines nearly to the corneous tip of the pollex, these spines are similar, though smaller, to those on the major hand, the inner margin is unarmed, lightly setose, as is the under side of the hand.

The ambulatory legs are unarmed on their upper crests, lightly setose, with a high polished surface, shorter than the major chela.

The terminal segment of the abdomen is a single, undivided, semioval plate, the distal margin unarmed, entire, and projecting equally on both sides.

Color: In alcohol, an ivory mottled with red. The spines of the chelipeds have a faint purple tint. The ambulatories are banded with red and a bluish-white, the latter color is distal on the joints.

Measurements: Length from rostrum to telson 19 mm., of carapace 5 mm., of anterior portion of carapace 3 mm., width 3 mm., length of major chela 12.5 mm., of merus 2.3 mm., of carpus 3 mm., of flat portion of manus 5 mm., width 3.8 mm., length of minor manus 3 mm., width 1.5 mm., length of eye-stalk 2.4 mm.

Range: Known only from type-locality.

Remarks: This proposed species is allied to *P. coronatus* (Benedict), 1892, but differs in that the merus of the major cheliped is lightly rugose, instead of with a thin subserrate crest; by the carpus being uncrested on the median line, instead of with a subserrate crest; by the spines bordering the hand being tipped with minute, corneous spinules, instead of being untipped with spinules; by the minor hand having its outer margin serrate with teeth, instead of having a subserrate ridge. In both species the ultimate segment of the telson is similar.

This species is named for Guatemotzin, or Guatemoc, the last Aztec sovereign in Mexico.

Pylopagurus spinicarpus Glassell, manuscript name.

Material: A total of 2 specimens was taken from Santa Inez Bay (Station 147), and Gorda Bank (Station 150), between 60 and 80 fathoms

The specimens were distributed as follows:

Station 147: D-2 (1 male); 60 fathoms.
Station 150: D-13 (1 male); 70 to 80 fathoms.

Genus *Pagurus* Fabricus.

Key to species of Pagurus *collected on this expedition.*

A. Eye-stalks short, stout; cornea dilated.
  B. Hand margined with spines, granulose. Antennal acicle extending past cornea. Rostrum not advanced past laterals.
    C. Hand about twice as long as wide. *P. smithi*, p. 259
    C′. Hand about as long as wide. *P. merimaculosus*, p. 259
  B′. Hand not margined with spines, granulose.
    C. Hand 3 times as long as wide. Antennal acicle extending past cornea. Rostrum advanced past laterals. *P. gladius*, p. 257
    C′. Hand about twice as long as wide. Antennal acicle not extending past cornea. Rostrum not advanced past laterals, or, but slightly advanced. *P. albus*, p. 258

A′. Eye-stalks cylindrical, stout; cornea slightly dilated. Antennal acicle not extending past cornea.
  B. Hand margined with spines, spinulose, setaceous; about twice as long as wide. Rostrum advanced past laterals. Pollex deeply concave. *P. pollexcavus*, p. 261
  B′. Hand not margined with spines, granulose; about as long as wide. Rostrum not advanced past laterals. Pollex not concave. *P. californiensis*, p. 257

A″. Eye-stalks expanded at their base; cornea not dilated. Antennal acicle not extending past cornea. Hand margined with spines, spinulose, setaceous; about twice as long as wide. Rostrum advanced past laterals. *P. lepidus*, p. 256

Pagurus lepidus (Bouvier), new combination.

Eupagurus lepidus Bouvier. *Bull. Mus. d'Hist. Nat. Paris*, no. 8, 1898, p. 381 (type-locality, La Paz Bay, Baja California).

General Range: Gulf of California.

Local Distribution: A total of 5 specimens was taken near shore at Santa Inez Bay (Station 144 D-1), at a depth of 1 fathom.

Sex and Size: This series contains 3 males and 2 ovigerous females. The largest specimen, a male, has the following dimensions: length from rostrum to telson 13.5 mm., of carapace 3.8 mm., of precervical portion of carapace 2.4 mm., width of same 2.2 mm., length of merus of major cheliped 1.8 mm., of carpus 1.6 mm., of manus 3 mm., width of same 1.5 mm., length of eyestalk 1.6 mm.

Color: In alcohol, the carapace is a buff. The merus of the chelipeds is red-brown and buff, the hands and carpus yellow, the finger tips white. Ambulatory legs cream, with all joints striated with red-brown. Flagellum of antennae with 3 or more segments red-brown separated from the next series by a white segment.

Habitat: This little hermit crab frequents the lower tidal levels, seeking shelter among marine growths.

Remarks: This is the first record of this species having been taken in the Gulf of California in 40 years. It may be mentioned, however, that it is not a rare form, but obscure.

Pagurus californiensis (Benedict).

Eupagurus californiensis Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 21 (type-locality, California); Faxon, *Mem. Mus. Comp. Zool. Harvard*, vol. 18, 1895, p. 55, pl. 11, figs. 2-2f; Bouvier, *Bull. Mus. d'Hist. Nat. Paris*, 1898, p. 382.

Pagurus californiensis (Benedict). Holmes, *Occas. Papers Calif. Acad. Sci.*, vol. 7, 1900, p. 149; Rathbun, *Harriman Alaska Expedition*, vol. 10, 1910, p. 161; Schmitt, *Univ. Cal. Pub. Zool.*, vol. 23, 1921, p. 143, text-fig. 93; Boone, *Zoologica*, N. Y. Zool. Soc., vol. 14, no. 1, 1932, p. 9, text-fig. 3.

General Range: From California to Panama. Galápagos Islands (Boone).

Local Distribution: A total of 14 specimens was taken from Arena Bank (Station 136) and Santa Inez Bay (Stations 142 and 143 respectively), at depths ranging from 25 to 50 fathoms.

Sex and Size: The collection numbers 6 males and 8 females. The largest male (Cat. No. 36,790) from Santa Inez Bay (Station 143 D-4) has the following measurements: length from rostrum to telson 40 mm., of carapace 10 mm., of precervical portion of carapace 6.1 mm., width of same 5.6 mm., length of major cheliped 29 mm., of merus 7.2 mm., of carpus 7 mm., of manus 12.5 mm., of dactyl 6.3 mm., width of manus 9.8 mm., length of eye-stalk 5 mm.

Habits, Habitat: In the Gulf of California, this species is only found in depths ranging from 15 to 50 fathoms, while along the California coast, in cooler waters, it is often taken at low tide. Faxon records his specimens at a depth of 66 fathoms, at Panama. Boone records her specimens as having been taken at a depth of 2½ fathoms, in the cooler waters of the Galápagos Islands.

Remarks: This species registers considerable variation in the smoothness of the upper surface of the hand, some specimens being quite tuberculate on the distal half, others smooth. The size and shape of the inner margin of the hand also shows considerable variation in different individuals, some being much larger than others, although the individuals may be of the same size.

Pagurus gladius (Benedict).

Eupagurus gladius Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 7 (type-locality, Gulf of California); Nobili, *Boll. Mus. Zool. Anat. comp. R. Univ. Torino*, vol. 16, no. 415, 1901, p. 22.

Pagurus gladius (Benedict). Rathbun, *Proc. U. S. Nat. Mus.*, vol. 38, 1910, p. 597.

General Range: From the Gulf of California to Ecuador (Nobili).

Local Distribution: A total of 11 specimens was taken from Arena Bank (Station 136 D-14), and Santa Inez Bay (Station 143 D-2 and D-5), at depths ranging from 18 to 45 fathoms.

Sex and Size: The collection numbers 6 males and 5 females, the greater number of these being half grown. As the two largest specimens in this

series had lost their major chelipeds, it was thought best to give the measurements of a normal adult male, in the author's collection, taken off Carmen Island, in Salinas Bay, Gulf of California; December 19, 1931; in 30 fathoms. The above specimen has the following dimensions: length from rostrum to telson 28 mm., of carapace 10 mm., of precervical portion of carapace 4.8 mm., width of same 6 mm., length of major cheliped 41.5 mm., of merus 11 mm., of carpus 11 mm., of manus 16.5 mm., of dactyl 6.5 mm., width of manus 4.5 mm., length of eye-stalk 4 mm.

Color: In alcohol, the carapace is a dark cream maculated with red and purple. Chelipeds and ambulatories with a purple tinge and red spots; a dark purple stain on hand near dactyl; propodus and dactyli of ambulatories banded with purple. Eye-stalks mottled.

Habits, Habitat: This active pagurid apparently occupies the zone between the depths of 20 and 50 fathoms; at any rate it has not so far been reported from the tidal zone. It prefers a small, fragile shell, which only partly covers its carapace. This shell, like those favored by *P. splendescens* Owen, 1839, becomes partly disintegrated from the action of the polyps or bryozoans which cover the anterior portion of the shell.

Remarks: As it is not known at what part of the Gulf of California the type specimen was found, it is impossible to state an extension of range, even though it be a distance of several hundred miles, until specimens are collected outside of this area. It is possible also, that Nobili had a different species to work on, for he finds differences between his specimen and Benedict's description, which an examination of a series, such as this, from the Gulf of California, does not bear out.

Pagurus albus (Benedict).

Eupagurus albus Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 6 (type-locality, Gulf of California).

Not *Pagurus albus* (Benedict). Boone, *Bull. Vanderbilt Marine Mus.*, vol. 3, 1930, pp. 34-36, pl. 5.

General Range: So far known only from the Gulf of California.

Local Distribution: A single specimen from Santa Inez Bay (Station 144 D-7), taken at a depth of 3 fathoms.

Sex and Size: A single, partly damaged, juvenile female. As this specimen may not be suitable for measurement, I will supply the dimensions of a normal male, collected by myself on Turner Island, Gulf of California; December 31, 1931; in the inter-tidal zone. The measurements are: length from rostrum to telson 26 mm., of carapace 9.5 mm., of precervical portion of carapace 5.5 mm., width of same 5.7 mm., length of major cheliped 23 mm., of merus 5.8 mm., of carpus 6.3 mm., of manus 8 mm., of dactyl 4.2 mm., width of manus 3 mm., length of eye-stalk 3.8 mm.

Color in Life: The conspicuous feature of this crab is the whiteness of the hands.

Habits, Habitat: This pagurid is a tidal form which may be taken at shallow depths. It is extremely active, a fast traveler, and is found racing along the bottom in a few inches of water at extreme low tide. At no collecting station, in spite of their conspicuous color, have they been observed to be very numerous.

Remarks: This species appears to be closely allied to *P. gladius* (Benedict), but while *P. gladius* occupies the lower zone in the same region, *P. albus* occupies the upper.

Pagurus smithi (Benedict), new combination.

Eupagurus smithi Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 4 (type-locality, Gulf of California).

Not *Eupagurus smithii* Milne Edwards and Bouvier. *Mem. Mus. Comp. Zool.*, vol. 14, no. 3, 1893, p. 140, pl. 10, figs. 1-12 (type-locality, Sand Key, Florida), (= *Pagurus bouvieri* (Faxon), 1895).

General Range: So far only known from the Gulf of California.

Local Distribution: A total of 9 specimens was taken at Santa Inez Bay (Station 143 D-1, D-2, D-3 and D-5), at depths ranging from 18 to 35 fathoms.

Sex and Size: This series consists of 2 males and 7 females. The largest male (Cat. No. 36,291) has the following dimensions: length from rostrum to telson 58 mm., of carapace 17 mm., of precervical portion of carapace 7.6 mm., width of same 8.5 mm., length of major cheliped 33 mm., of merus 10 mm., of carpus 8.5 mm., of manus 13.1 mm., of dactyl 7.5 mm., width of manus 7.5 mm., length of eye-stalk 7 mm.

Color in Alcohol: Carapace and eye-stalks buff. Chelipeds with carpus and manus a light orange; inner margins of pollices and dactyli white. Ambulatory legs buff.

Habitat: Evidently not a shore form, as they were only found at depths ranging to 35 fathoms.

Remarks: Bottom conditions may have something to do with the apparently localized finding of this form, as they were taken at only one Station (143). The original description gives the type-locality as Gulf of California, so that we have little information on the original finding, as to depth or distribution. This is the first record of the taking of this pagurid in 45 years.

Pagurus merimaculosus, sp. nov.

Type: Male, holotype; Cat. No. 361,126, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 14; from the Gulf of California, 23° 29′ 30″ N. Lat., 109° 25′ W. Long., 3 miles northeast of Cape Pulmo, Lower California, Mexico; 45 fathoms; bottom muddy; April 20, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Precervical portion of carapace about as long as wide, almost naked. Front obtuse, not extending past laterals. Eye-stalks stout, short; cornea dilated. Antennal acicle extending past eye. Carpus of major hand concave on inner side, margined with 9 or more conical spines; hand 3/5 as wide as long, heavily plated with short spined granulations. Inner and outer distal ends of meri of chelipeds and 1st and 2nd ambulatories with a distinctive blood-red spot.

Description: Calcified portion of carapace about as long as wide, almost naked, except for a few short setae. Rostral projection obtuse, not extending past the laterals, nor much more than reaching the bases of the eye-scales; lateral projections equilateral, armed with a minute subapical spine.

Eye-stalks stout, nearly 2/3 the length of the anterior portion of the carapace, cornea expanded. Ophthalmic scales distant, semioval at base, subacute, concave distally, margins entire; a small subterminal spine.

The antennal acicles are long, narrow, sharp-pointed, and extend past the eyes to a point near the base of the flagellum.

The major cheliped is large, strong, wide, well margined; merus extending well past the eyes, inner side straight, outer side rounding, the distal

posterior margins of both sides have a row of small teeth; the upper flattened carpal margin is armed with a row of horizontal, long, sharp spines; the carpus increases in width distally, where it is more than 2/3 as wide as long; the inner margin is armed with a row of forward- and upward-pointing spines, the outer margin is well defined, granulous, and with a row of setae; the upper surface is slightly convex, rugose and granulate, more prominent distally; the surface of the outer side of the carpus is vertical, that of the inner concave; the hand is rectangular, 3/5 as wide as long; the inner and outer margins are armed with a row of regularly spaced, outward- and upward-pointing, conical teeth; the proximal margin armed with 2 conical, vertical teeth, one near the inner hinge, the other median; the upper surface is slightly convex and densely pebbled or plated with irregular, sharp-tipped granules, continued onto the pollex and dactyl, these granules have distinct margins and do not coalesce; the dactyl is crested with spines, as is the hand, and is armed on its prehensile edge with calcareous blunt teeth, as is the pollex. The minor cheliped is slightly shorter than the major, the corneous tips of the fingers reaching to a point about midway on the major dactyl; the merus is compressed, rounded on top, and like the major merus is distally armed with spines on the upper carpal and outer distal margins, but is unarmed on the inner side; the lower surface of both meri is tuberculate; the carpus is of irregular shape, narrower proximally than distally, and wider ventrally than dorsally at the distal end; the outer upper margin has a crest of sharp-pointed, conical spines, those of the inner margin are much smaller; the surface between the crests is concave and lightly roughened; the hand is subcylindrical, oval in transverse cross-section and bends downward at the tip; the surface is similar to that of the major hand; the inner edge of the pollex is covered with a multitude of small conical teeth; the inner edge of the dactyl is unarmed except for a short pile of baleen-like material.

The 1st and 2nd ambulatory legs are slightly longer than the chelipeds, sparsely crested with short setae, almost smooth, shining; the distal upper end of the carpus of the 1st legs is armed with two spinules, those of the 2nd legs with one; the dactyli are compressed, slightly contorted, smooth and shining on the posterior side and lightly setaceous anteriorly; including their corneous tip, they are nearly equal in length to the two preceding joints combined.

Color: In alcohol, the eye-stalks and ambulatory legs appear to be banded with a light pink and ivory. The most distinctive markings are the blood-red spots on each side of the distal, inner and outer ends of the meri of the chelipeds and ambulatory legs; these spots persist undimmed for a long time in preservative.

Measurements: Male holotype: length from rostral projection to telson 45 mm., of calcified portion of carapace 7 mm., width 7.3 mm., length of eye-stalk and cornea 5.3 mm., width of cornea 2.4 mm., length of acicle 5.1 mm., of major cheliped 34 mm., length of merus 8 mm., carpus 9 mm., distal width 7 mm., proximal width 4.5 mm., length of hand 15 mm., width 9 mm., length of minor hand 11 mm., width 4.5 mm., length of dactyl 7.5 mm.

Range: So far known only from the lower end of the Gulf of California.

Material Examined: A series of 28 specimens, 12 males and 16 females, some ovigerous, from Arena Bank (Station 136), off Cape Pulmo, Lower California, Mexico; in from 35 to 45 fathoms; April 3 to 30, 1936. Also, a series of 16 specimens, 8 males and 8 females, from Santa Inez Bay (Station 143), Lower California, Mexico; in 40 fathoms; April 11, 1936. Both series collected by William Beebe. The types were selected from the first series.

Remarks: This proposed species is allied to *P. smithi* (Benedict), 1892, the major chelipeds being somewhat similar in conformation; the granules of the hands and the shape of the dorsal surface of the carpus in the two

species are much alike; however, they differ in the minor hands. In *P. smithi*, the minor hand is similar to that of the major hand, being flattened, instead of being unrelated and subcylindrical. In *P. merimaculosus*, the upper crest of the carpi of the ambulatory legs has only one or two spinules at their upper distal end, while in *P. smithi*, the entire crest of the carpal joints is spinulose. In addition, *P. smithi* would appear to be a smaller form.

Pagurus pollexcavus, sp. nov.

Type: Male, holotype; Cat. No. 361,127, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 13; from the Gulf of California, 23° 02′ N. Lat., 109° 27′ 30″ W. Long., off Gorda Point, Lower California, Mexico; 75-80 fathoms; bottom sandy; April 23, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Precervical portion of carapace as long as wide; median tooth wide, triangular, slightly exceeding laterals. Eye-stalks stout, cylindrical; cornea slightly dilated. Antennal acicle not extending past cornea. Hands nearly twice as long as wide, margined with spines; upper surface on proximal half heavily spined and setose; pollex and dactyl concave, naked, smooth, paved with gear-edged, coalesced granules. Ambulatory legs unarmed except for upper distal carpal spinules. Distal margin of telson toothed.

Description: Calcified portion of carapace about as long as wide, naked, except for a few tufts of short setae. Posterior margin of carapace deeply indented. Rostral tooth broadly triangular, exceeding laterals and extending between bases of eye-scales; lateral projections obtuse, with a minute subapical spinule.

Eye-stalks stout, cylindrical, subequal in length to major dactyl; cornea slightly dilated. Ophthalmic scales distant, broad at base, apex triangular, surface slightly concave between margins; a strong subterminal spine. Distal end of 2nd antennular peduncle just reaches the cornea.

The antennal acicles are slightly arcuate, unarmed, with few setae, and extend well into the cornea. The 3rd peduncle of the antennae exceeds the cornea by 1/3 its length. The flagellum exceeds the length of the major cheliped and has a few short cilia.

The major cheliped is 2/3 the length of the body; the merus is armed on its distal upper edge with a single forward-pointing spine; the upper and outer surface is lightly rugose; the inner and outer lower margins are spinulose; the under surface tuberculate; the carpus is widest distally, where it is subequal in width to the hand, its inner margin armed with a row of 6 or more forward-pointing, conical spines, inside of which are several smaller spines; the outer margin is not defined with spines; the upper surface is lightly setose, with small, scattered, sharp-tipped granules; the manus is nearly twice as long as wide, heavily spined and setose on its proximal half; the pollex is deeply concave from its upward-pointing, spined outer margin to a median longitudinal row of spines from base to tip; the concave surfaces of the pollices and dactyli of both hands are paved with smooth, closely meshed, coalesced, gear-edged granulations; the fingers are armed with calcareous lobes, and gape slightly from base to apex. The minor cheliped reaches to the base of the dactyl of the major hand; the merus is compressed and deep, it is armed on its distal, outer ventral margin with a prominent row of spines; the carpus is narrow and deep, the thickness being nearly 2/3 the length, proximally the upper surface is bicrestate, unicrested distally on the outer margin; distally the lower outer margin is spined; the manus is somewhat similar to that of the major hand, except that the concave pavement extends, on the outer half, to a point near the proximal end; the

remainder of the upper surface of the hand is setose, with a median row of spines which margin the paved area.

The ambulatory legs are subequal in length to the major cheliped, lightly setose; the carpi armed at their distal upper ends with a single spinule; the dactyli are compressed and slightly longer than their propodi. The terminal lobes of the telson are armed on their inner margins with 4 or more well spaced, incurving spines.

Color: In alcohol, the ground color is an ivory, overlaid with pink and spotted with small blood-red spots. The under side of the eye-stalks is red, the upper part a cream. The propodi of the ambulatories have a median band of pink. The setae are a straw yellow.

Measurements: Male holotype: length from rostrum to telson 41 mm., of carapace 10 mm., of anterior portion of carapace 5.5 mm., width 5.5 mm., length of major cheliped 30 mm., of merus 5.8 mm., of carpus 6.5 mm., of manus 10 mm., of dactyl 5 mm., width of manus 6 mm., length of eye-stalk 4.5 mm., distance between laterals 3 mm.

Material Examined: A series of 10 males and 12 females, 1 ovigerous, from Gorda Bank (Station 150), off Gorda Point, Lower California, Mexico; in from 67 to 80 fathoms; April 21 to May 3, 1936. The types were selected from this series. Three specimens, 1 male and 2 females, 1 ovigerous, from Arena Bank (Station 136), 3 miles NE of Cape Pulmo, Lower California, Mexico; in from 42 to 50 fathoms; May 1-2, 1936. All collected by this expedition.

Range: So far only known from the lower end of the Gulf of California.

Remarks: This proposed species is distantly allied to *P. tanneri* (Benedict), 1892, which it somewhat resembles in the shape of the carapace and general contour of the chelipeds; it differs in that the median tooth of the carapace is not so far advanced, the eyes not so stout and dilated, the antennal acicle not so long; the merus and carpus of the chelipeds are somewhat similar, but the hands differ by being spined and setose on the proximal half, instead of tumid and spined in a regular pattern; the pollex is deeply concave and smoothly paved, instead of slightly concave and spinulose; by the ambulatory legs being unarmed, instead of armed on the crests of the carpus and propodus.

Pagurus bunomanus Glassell, manuscript name.

Material: A total of 8 specimens was taken from Arena Bank (Station 136), and Clarion Island (Station 163 D-2), in the Revilla Gigedo Group, 3 miles off Pyramid Rock, in depths ranging to 50 fathoms.

The specimens were distributed as follows:

Station 136: (3 males, 1 female).
Station 163: D-2 (1 male, 3 females, 1 ovigerous); 50 fathoms.

Genus *Catapagurus* Milne Edwards.

Catapagurus diomedeae Faxon.

Catapagurus diomedeae Faxon. *Bull. Mus. Comp. Zool. Harvard*, vol. 24, no. 7, 1893, p. 171 (type-locality, off Cocos Island); and, *Mem. Mus. Comp. Zool. Harvard*, vol. 18, 1895, p. 57, pl. 13, figs. 2-2d.

General Range: From the Gulf of California to the Bay of Panama.

Local Distribution: A total of 4 specimens was taken on Arena Bank (Station 136) and in Santa Inez Bay (Stations 146 D-1 and 147 D-2 respectively), at depths ranging from 35 to 60 fathoms.

Sex and Size: The entire series is composed of 2 males and 2 females, one a juvenile. The largest female specimen from Arena Bank, has the following measurements: length from rostrum to telson 23 mm., of carapace 7.6 mm., of precervical portion of carapace 4.5 mm., width of same 4 mm., length of cheliped 18 mm., of merus 4.8 mm., of carpus 4.8 mm., of manus 6.5 mm., of dactyl 2.7 mm., width of manus 2.1 mm., length of eye-stalk 3.4 mm.

Color in Alcohol: Carapace, chelipeds and eye-stalks, a cream with light red markings. Chelipeds and ambulatory legs with yellow setae, pollex with a purple banding. Walking legs with pink or purple banding.

Remarks: This record is not only an extension of range for this species, but it is also the first record of the species having been taken since Faxon described and figured it. Faxon's specimen was taken at a depth of 182 fathoms, while the above series was collected at a depth not to exceed 60 fathoms.

Genus *Spiropagurus* Stimpson.

Spiropagurus occidentalis Faxon.

Spiropagurus occidentalis Faxon. *Bull. Mus. Comp. Zool. Harvard,* vol. 24, no. 7, 1893, p. 172 (type-locality, off Cocos Island); and, *Mem. Mus. Comp. Zool. Harvard,* vol. 18, 1895, p. 59, pl. 14, figs. 1-1d.

General Range: From the Gulf of California to the Bay of Panama.

Local Distribution: A total of 4 specimens was taken on Arena Bank (Station 136), and in Santa Inez Bay (Station 147 D-2), at depths ranging from 35 to 60 fathoms.

Sex and Size: This series consists of 2 males and 2 females, one ovigerous, all of small size. The largest male from Station 136 has the following dimensions: length from rostrum to telson 16.5 mm., of carapace 5.5 mm., of precervical portion of carapace 3.5 mm., width of same 3.2 mm., length of cheliped 12.7 mm., of merus 3.2 mm., of carpus 3 mm., of manus 5.5 mm., of dactyl 2.2 mm., width of manus 2.1 mm., length of eye-stalk 2.2 mm.

Color in Alcohol: Nearly all trace of color has disappeared in solution from the carapace and chelipeds, except for small purple markings along the margins of the hands and purple bands near the fingers; also there is purple on the spines of the carpus. The ambulatory legs appear to have been banded purple and white.

Remarks: This record extends the range for this species from Cocos Island, off Panama, to the Gulf of California. It is also the first record of the species having been taken since its discovery. The bathymetric ranges are very similar.

17.

Caudal Skeleton of Bermuda Shallow Water Fishes. II. Order Percomorphi, Suborder Percesoces: Atherinidae, Mugilidae, Sphyraenidae[1].

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(Text-figures 1 to 14).

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INTRODUCTION.

This is the second of a series of papers dealing with the caudal skeleton of Bermuda fishes.[2] This paper deals principally with the adult fishes, as does Part I on the Bermuda Isospondyli, but when young stages were available these were included.

In Atherinidae, *Menidia notata* is known from Bermuda by a single record, (Barbour, *Bull. Mus. Comp. Zool.*, vol. XLVI, No. 7, page 116, 1905). The single specimen upon which it is based could not be found. This record is questionable and it is possible that *Menidia* does not exist in Bermuda. The account of *Menidia menidia* has already been shown to be *Atherina harringtonensis.* (Beebe and Tee-Van, *Zoologica,* XIII, 7, 1933, page 143). *Menidia* has not been taken by us and as *Atherina* is common, *Menidia notata* is not included in this study, on the assumption that the single record is the same as *Atherina harringtonensis.*

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[1] Contribution No. 532, Department of Tropical Research, New York Zoological Society.

Contribution from the Bermuda Biological Station for Research, Inc.

[2] Caudal Skeleton of Bermuda Shallow Water Fishes. I. Order Isospondyli: Elopidae, Megalopidae, Albulidae, Clupeidae, Dussumieriidae, Engraulidae. *Zoologica,* New York Zoological Society, Vol. XXI, Dec. 31, 1936.

Key to Caudal Fin of Bermuda Shallow Water Percesocid Fishes.

(Text-figs. 1-3).

PERCOMORPHI

Percesoces

Group I

Broad posterior neural and haemal spines;
21 caudal vertebrae;
43 total vertebrae;
2 epurals, rarely 1.

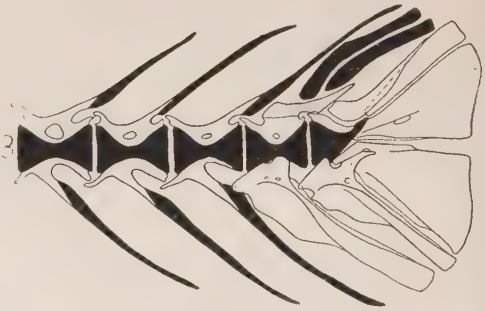
ATHERINIDAE
Atherina harringtonensis

Text-figure 1.

Sub-Group A

2 epurals;
epural bases anterior to neural of last centrum;
neural of last centrum sharply pointed;
13 caudal vertebrae;
Post. haemal processes arise on anterior half of centra.

MUGILIDAE
Mugil curema
Mugil trichodon
Mugil brasiliensis



Text-figure 2.

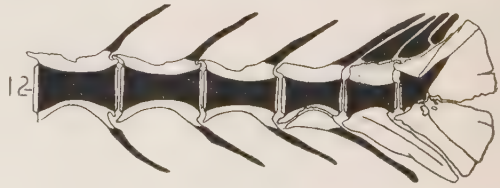
Group II

Slender posterior neural and haemal spines;
12 or 13 caudal vertebrae;
24 total vertebrae;
2 or 3 epurals.

Sub-Group B

3 epurals;
epural bases not anterior to neural of last centrum;
neural of last centrum not pointed;
12 caudal vertebrae.
Post. haemal processes arise on post. half of centra.

SPHYRAENIDAE
Sphyraena barracuda
Sphyraena borealis



Text-figure 3.

In Mugilidae, *Mugil curema* is the common species. *Mugil trichodon* and *Mugil brasiliensis* are the uncommon species. The latter has not been taken during our seven seasons of work in Bermuda. Three specimens were presented for this study by the United States National Museum.

In Sphyraenidae, *Sphyraena sphyraena* is omitted, being a questionable species in Bermuda. In the "Field Book of the Shore Fishes of Bermuda," Beebe and Tee-Van, it "has twice been recorded from Bermuda. Both records are questionable and it is possible that the fish does not occur here at all." Because of almost identical characters of the osteology of the tail, *S. borealis* and *S. picudilla* are in this paper considered as one, and the name *Sphyraena borealis*, is used for both.

The length of specimens in this paper is standard length unless otherwise stated.

For caudal fin terminology, complete bibliography, and method of preparing specimens for this study, refer to Part I.

The symbols used in the figures are UN, uroneurals; EP, epurals; 1, 2, 3 etc., hypurals.

We are indebted to the American Museum of Natural History for specimens of *Menidia notata* and to the U. S. National Museum for three specimens of *Mugil brasiliensis*. I take this opportunity to thank Dr. William Beebe, Director of this Department, for his continued encouragement, and Mr. John Tee-Van for his cooperation. The drawings are by Mr. George Swanson and the author.

In the key a single figure is used to represent the three species of Mugilidae and another for the two species of Sphyraenidae. In both families the drawings are of the largest adults of the common species, *Mugil curema* and *Sphyraena barracuda*. The slight differences found in the caudal pattern of the other species are described in the text.

ATHERINIDAE.

Atherina harringtonensis Goode.

(Text-figs. 4-7).

Diagnostic Characters:

4 hypurals, 2 dorsal and 2 ventral in 64 mm. fishes.

5 hypurals, 3 dorsal and 2 ventral in 28 mm. and smaller fishes.

Several broad posterior neural and haemal spines.

2 epurals in all specimens but one of 64 mm.

Vertebral count: 21 caudal plus 22 trunk. Total 43.

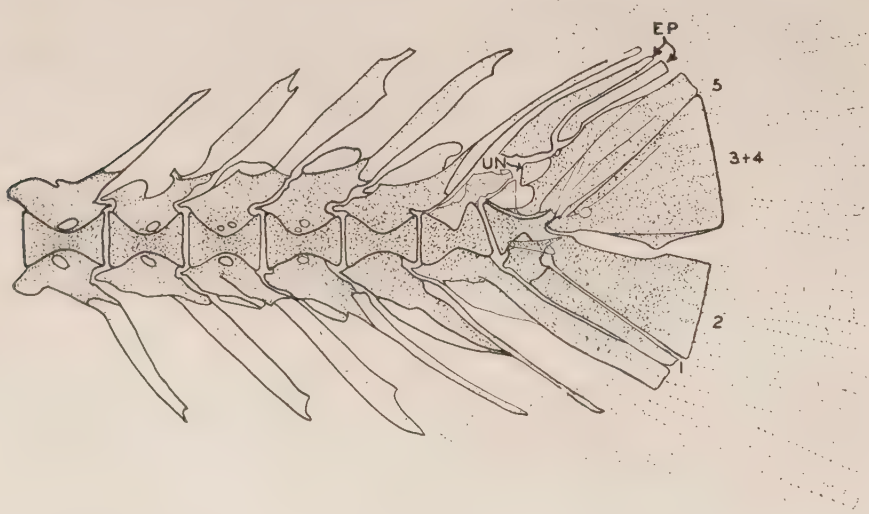
Material Studied.

Length.	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
64 mm.	654	4	Complete.
60 mm.	855		"
55 mm.	654		"
52 mm.	654		"
50 mm.	205		"
50 mm.	656		"
47 mm.	206		"
47 mm.	1072		"
45 mm.	654		"
38 mm.	654		"
37 mm.	205		"
35 mm.	206		"
35 mm.	654 (2 spec.).		"

Length.	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
28 mm.	654 (2 spec.).	5	Complete.
13 mm.	2106 (2 spec.).	6	Partial.
9 mm.	2106		Slight, vertebral column segmented.
6 mm.	2106 (2 spec.).	7	None, vert. column unsegmented.
5 mm.	2106	7	None.

Caudal Osteology.

Urostyle: Separate segments of the urostyle cannot be found in any of the specimens examined which range in size from 5 mm. to 64 mm. In the 64 mm. fishes the urostyle is very much reduced, its blunt posterior end appearing above the base of the dorsal fan-like hypural. In the 28 mm. specimen it is near the base of the 4th hypural. In the 13 mm. fish, which is not completely ossified, it is even more elongated and the tip is rounder and lies above the base of the 5th hypural. In the 5 mm. fish, which has no evidence of ossification, the vertebral segments are not developed and the urostyle extends dorsally beyond the distal margin of the 5th or dorsalmost hypural.



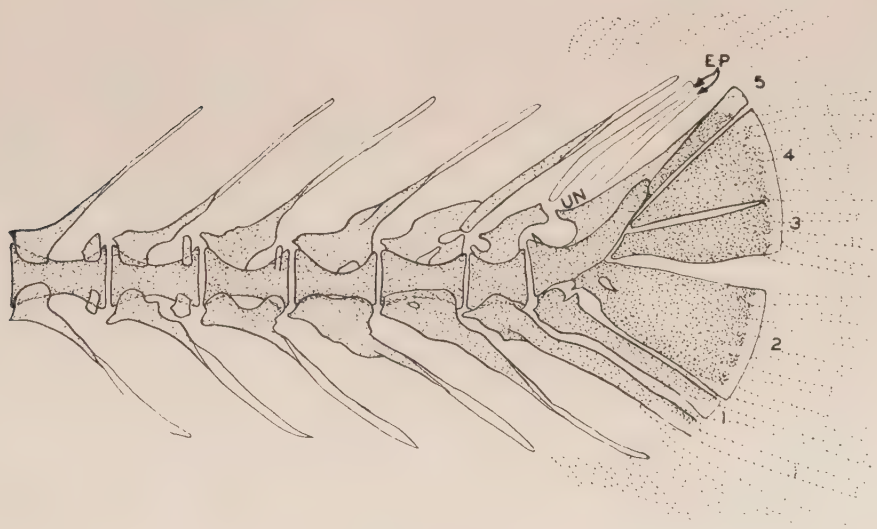
Text-figure 4.

Atherina harringtonensis. Tail of 64 mm. specimen with 3d and 4th hypurals fused and 5th hypural consolidated with the uroneural. (x 11.9).

Uroneurals: In the 13 mm. specimen one pair of uroneurals is present which covers all but the anterior margin of the dorsal surface of the urostyle which is covered by the diminutive zygapophysis. In the two larger stages the uroneurals are enlarged and have become one with the base of the zygapophysis, and the depth has increased so that the area between the urostyle and the epurals is almost completely filled. In the 13 mm. fish the distal end of the uroneurals is closely connected with the dorsal surface of the dorsalmost hypural. In the larger specimens the line of junction between the two is faint and the identity of the two bones is further complicated by additional lines. But from the structure of the 13 mm. specimen it is thought that the adult has but one pair of uroneurals.

Text-figure 5.

Atherina harringtonensis. Tail of 28 mm. specimen with the five hypurals defined but the dorsal surface of the 5th united with the uroneural. (x 29.8).

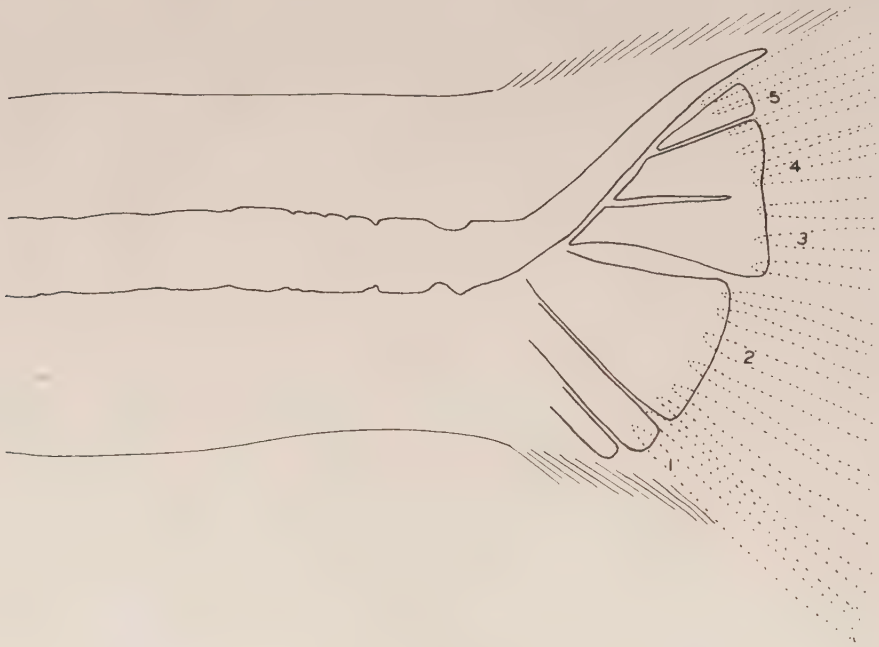


Text-figure 6.

Atherina harringtonensis. Tail of 13 mm. specimen with the unossified areas not stippled. (x 45.6).

Hypurals: There are four hypurals, two below and two above the median line, in the largest or 64 mm. specimens. In the 28 mm. and smaller fishes there are five hypurals, two below and three above the median line. In

all specimens there remains evidence of a one-time division of the second hypural which is indicated by a small hole near the base. In the 28 mm. fish the heavy spine of the 1st hypural has been omitted in the illustration in order to show the base of the 2nd hypural with the hole and the double nature of the arch portion. (Text-fig. 5). In all of the Bermuda Isospondyli there are three hypurals below the median line, instead of two found in the Bermuda Percesoces.



Text-figure 7.

Atherina harringtonensis. Tail of 5 mm. specimen which is unossified. The column is unsegmented into vertebrae. (x 93.2).

In the 64 mm. *Atherina* the 3rd and 4th hypurals have united to form a large fan-shaped bone similar to the one below the median line. The complete outline of the 5th hypural is difficult to trace in specimens over 28 mm. in length when it becomes united dorsally with the uroneurals. In the younger stages it is clearly defined both in position and outline.

Epurals: There are two epurals in all specimens examined except one 64 mm. long. In the 13 mm. fish the epurals are not ossified and their outline can only faintly and incompletely be traced. In all larger specimens the epurals are long flat bones and the anterior one is always longer and broader, having a larger area to fill.

Specialized Neural Processes: The spine of the neural process on the terminal posterior centrum is greatly reduced, with a blunt distal portion which, in the large specimens, overlaps the zygapophysis of the urostyle and extends almost to the base of the anterior epural. The neural arches, as well as the haemal arches, have complicated superstructures which do not appear in the two other families of this suborder.

Caudal Fin Ray Count:

64 mm.	9 + 10 = 19	(Text-fig. 4).
	9 + 9 = 18	
28 mm.	9 + 8 = 17	(Text-fig. 5).
	9 + 8 = 17	
13 mm.	10 + 9 = 19	(Text-fig. 6).
	9 + 8 = 17	
9 mm.	17	
	16	
5 mm.	9	(Text-fig. 7).
	8	

MUGILIDAE.

1. **Mugil curema** Cuvier and Valenciennes.

Diagnostic Characters:

4 hypurals, 2 dorsal and 2 ventral in 10 mm. and larger fishes.

6 hypurals indicated in the unossified 6 mm. specimen.

Narrow posterior neural and haemal spines.

2 epurals whose bases are anterior to the tip of the neural of the last centrum.

Neural spine of the last centrum sharply pointed.

Haemal processes arising on the anterior half of the caudal centra.

Vertebral count: 13 caudal plus 11 trunk. Total 24.

Material Studied.

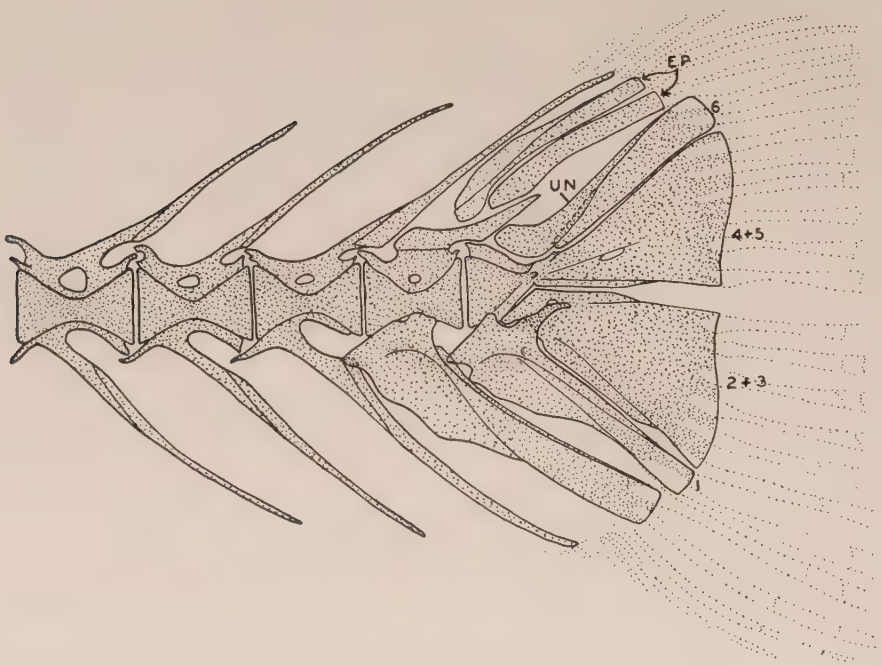
Specimens ranging in size from 4 mm. to 23 mm., taken in Haiti, were used for additional study but not tabulated below. One is included in this study which is a stage not found in our Bermuda material.

Length.	*Cat. No.*	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
202 mm.	9474	979		Complete.
149 mm.	25041	1045		"
70 mm.	25042	1044	8	"
49 mm.		593		"
32 mm.		593		"
32 mm.		503		"
30 mm.		503		"
30 mm.		2094		"
28 mm.		2094		"
25 mm.		2094		"
12 mm.*	16465	594	9	Partial.
10 mm.	7306 (Haiti).	2093	10	Partial, column segmented.
6 mm.†	19757b	2107	11	Slight, column unsegmented.

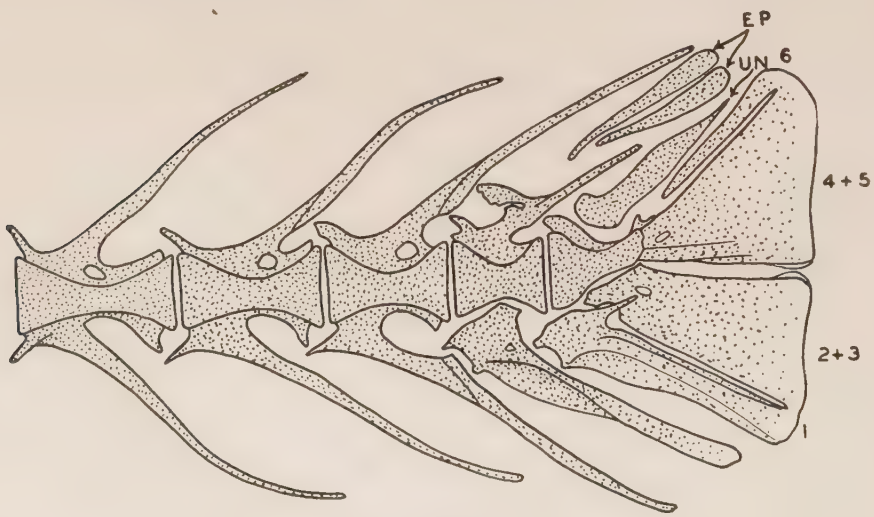
*Dip net 5 miles off shore.
†Surface net 3 miles off Gurnets.

Caudal Osteology.

Urostyle: The urostyle segment looks like a perfect half centrum. No separate elements can be seen in the reduced urostyle of specimens which range in length from 202 mm. to 12 mm. In a 10 mm. fish the upturned urostyle is more prolonged than in the 12 mm. specimen and extends to the

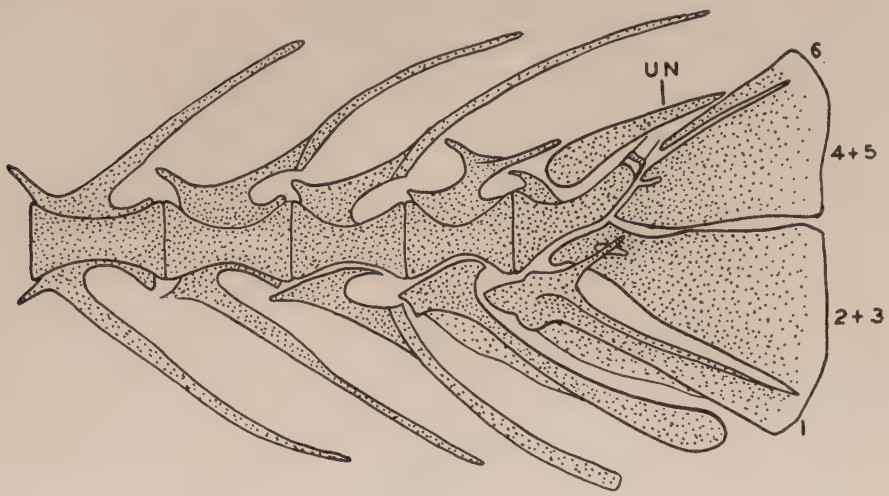


Text-figure 8.
Mugil curema. Tail of 70 mm. specimen which represents all larger stages in our collection. (x 8.7).



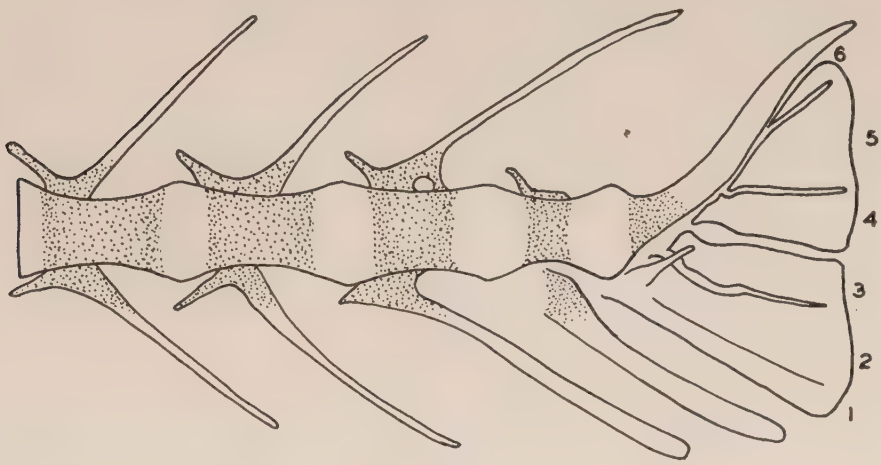
Text-figure 9.
Mugil curema. Tail of 12 mm. specimen showing remnants of the urostyle, immature epurals and uroneurals and partially ossified skeleton. (x 43.2).

dorsal margin of the base of the upper fan-shaped hypural. Extending beyond is the remnant of the unossified notochord. The 6 mm. specimen, which has only slight ossification in the center of the developing centra and



Text-figure 10.

Mugil curema. Tail of 10 mm. specimen only partially ossified, hypural bases free from upturned urostyle, margins of centra in conjunction, no epurals and skeleton only partially ossified. (x 53.7).



Text-figure 11.

Mugil curema. Tail of 6 mm. specimen which is only slightly ossified and the vertebral column as yet unsegmented. The urostyle is prolonged beyond the margin of the hypurals. The bases of six hypurals are distinct. (x 73.2).

the neural and haemal arches, has a prolonged notochord which curves dorsally beyond the margin of the dorsalmost hypural.

Uroneurals: There is one pair of uroneurals, the two bones of which are club-shaped ventrally and taper dorsally to a slender tip. In the 70 mm. specimen they extend almost to the dorsal margin of the 4th hypural. In this and larger specimens the ventral half of the uroneurals overlaps the side of the 4th hypural. In smaller specimens there is definite space between the two bones. In 12 mm. and 10 mm. fishes the dorsal tip reaches half and

a little more than half the length of their respective hypurals. In the slightly ossified 6 mm. specimen there is no evidence of the uroneurals.

Hypurals: There are four hypurals, two below and two above the median line in all specimens of 10 mm. and larger. There is indication of six hypurals in the 6 mm. specimen, none of which is ossified. Here the bases are deeply cleft but these do not extend through the distal margin to divide the bone into two hypurals. With growth the clefts gradually disappear and only a small hole remains at the base. This condition is also seen in *Atherina*. As in *Atherina* and *Sphyraena* there are two large fan-shaped hypurals, one dorsal and one ventral to the median line.

Epurals: Two epurals are present in all specimens ranging from 12 mm. to the largest. Both are long, flat bones which are slightly larger at the ventral end. The epurals are first seen in the 12 mm. fish and here the ventral ends are more slender than the dorsal. But with growth the ventral ends become larger. The bases of both epurals are anterior to the posterior tip of the last neural spine.

Specialized Neural Processes: The spine of the neural process on the terminal posterior centrum is reduced but more spine-like than in Atherinidae and Sphyraenidae. It differs from the neural process of both families in being long and slender and its pointed distal tip extending posteriorly and dorsally beyond the ventral bases of both epurals. The illustrations show the progressive growth of this bone.

Caudal Fin Ray Count:

149 mm.	5 + 10 = 15	
	6 + 10 = 16	
70 mm.	5 + 10 = 15	(Text-fig. 8).
	6 + 10 = 16	
49 mm.	4 + 10 = 14	
	6 + 9 = 15	
32 mm.	6 + 8 = 14	
	7 + 8 = 15	
25 mm.	7 + 8 = 15	
	8 + 8 = 16	
6 mm.	13	
	13	

Additional Characters Worthy of Note: The bases of the posterior caudal haemal arches arise anterior to the center of their centra and, on the posterior half of the centra, form a deep-cut U. This pattern is distinctive and does not exist in Atherinidae or Sphyraenidae. In the latter the haemal arches arise posterior, instead of anterior, to the center of the centra.

2. **Mugil trichodon** Poey.

3. **Mugil brasiliensis** Agassiz.

The caudal patterns of *Mugil trichodon* and *Mugil brasiliensis* are almost identical and are not noticeably different from *Mugil curema*. The vertebral count is the same in the three species; 13 caudal plus 11 trunk. Total 24.

In *Mugil trichodon* the scales are larger and the body more slender and the skeleton more slender and the reverse is true in *Mugil brasiliensis*.

MUGIL TRICHODON.

Material Studied.

Length.	*KOH Cat. No.*	*Cat. No.*	*Caudal Fin Ray Count.*
165 mm.	2167		4 + 10 = 14
			3 + 9 = 12
48 mm.	2168		4 + 10 = 14
			4 + 10 = 14
46 mm.	2168		6 + 9 = 15
			4 + 10 = 14

MUGIL BRASILIENSIS.

Material Studied.

190 mm.	2169	2128	3 + 10 = 13
		U. S. Nat. Mus.	5 + 9 = 14
92 mm.	2170	66247	
		U. S. Nat. Mus.	
35 mm.	2171	86914	5 + 9 = 14
		U. S. Nat. Mus.	4 + 9 = 13

SPHYRAENIDAE.

1. ***Sphyraena barracuda*** (Walbaum).

(Text-figs. 12-14).

Diagnostic Characters:

4 hypurals, 2 dorsal and 2 ventral in two largest fishes.

6 hypurals, 3 dorsal and 3 ventral in 115 mm. fish.

Narrow posterior neural and haemal spines.

3 epurals with bases of posterior two back of neural of the last centrum.

Neural of last centrum blunt.

Haemal processes arising on the posterior half of the caudal centra.

Vertebral count: 12 caudal plus 12 trunk. Total 24.

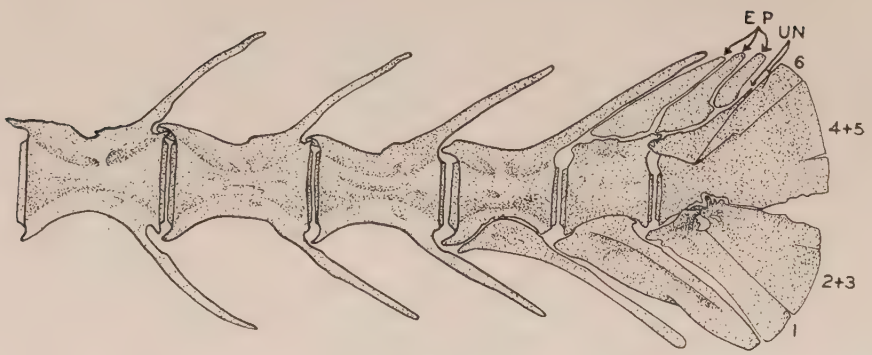
Material Studied.

Length.	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
750 mm. (2 spec.).	2117	12	Complete.
503 mm.	598	13	Complete.
115 mm.	2089	14	Complete.

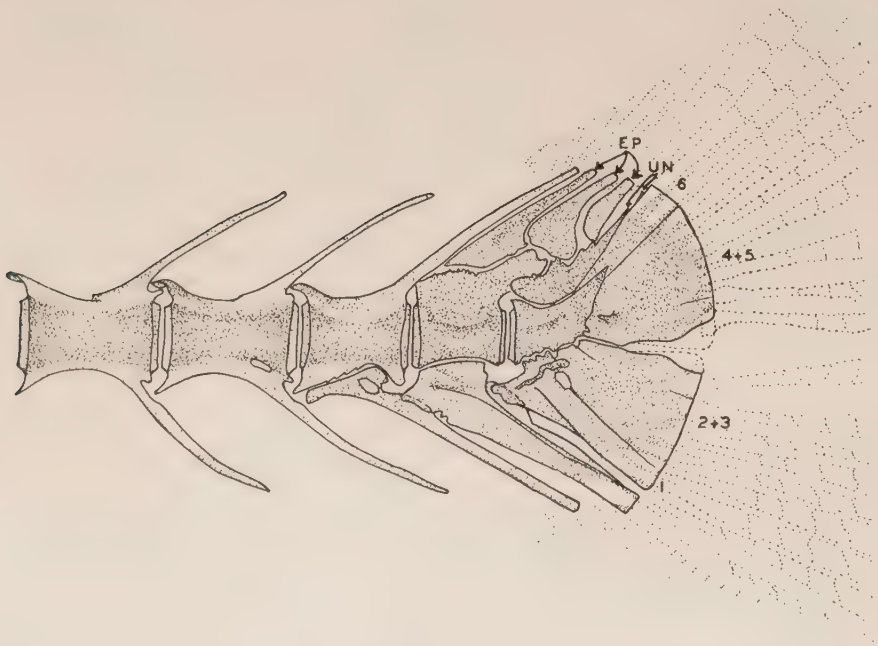
Caudal Osteology.

Urostyle: In the 750 mm. specimens, which are the largest in our collection, the urostyle appears completely consolidated with the bases of the 4th and 5th hypurals. On close examination the extremity of the urostyle can be seen as an inconspicuous tip about midway on the surface of the dorsalmost hypural. In the two smaller specimens the complete outline of the urostyle segment can be traced and in the 115 mm. fish it is more elongated, slender and separated from the surrounding bones.

Uroneurals: There are two pairs of uroneurals. Both are easily traced in the 115 mm. fish but the posterior pair is indistinct in the 503 mm. and



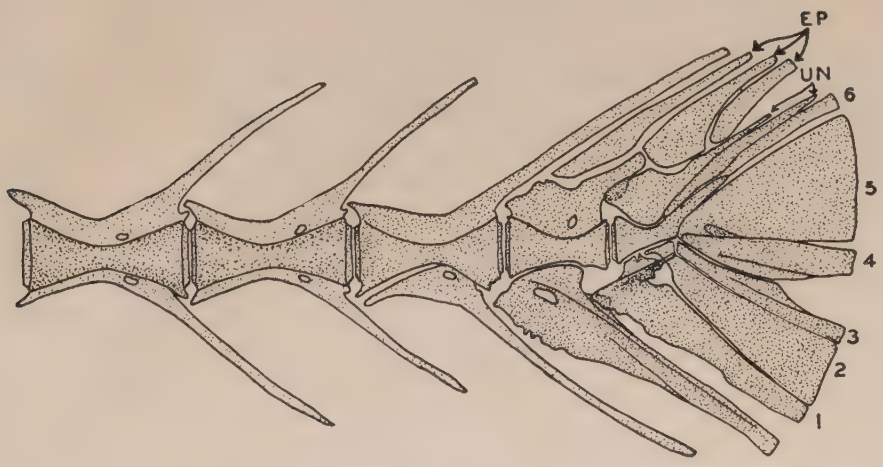
Text-figure 12.
Sphyraena barracuda. Tail of 750 mm. specimen showing fused hypurals, urostyle, and uroneurals. (x .8).



Text-figure 13.
Sphyraena barracuda. Tail of 503 mm. specimen showing only the trace of the urostyle and uroneurals. (x 1.38).

750 mm. specimens. Only the tip is evident near the distal end of the uppermost hypural with which it has become fused.

Hypurals: There are four hypurals, two below and two above the median line in the two largest fishes. But in each specimen a slight cleft is visible near the median line, in both of the large fan-shaped hypurals. In the 115 mm. specimens there are six complete hypurals. The clefts between the hypurals of the larger fishes are all that remain of the two additional



Text-figure 14.

Sphyraena barracuda. Tail of 115 mm. specimen showing form of six hypurals, the urostyle and two pairs of uroneurals. (x 6.5).

bones present in the younger stages. As in *Atherina* and *Mugil* the two median bones are large and fan-shaped.

Epurals: There are three epurals in all four specimens. The three epurals are club-shaped at the base and considerably narrower at their dorsal extremity. The anterior epural is the longest and the posterior one the smallest.

Specialized Neural Processes: The neural process of the terminal posterior centrum is blunt and heavy in form and the posterior neural end is never pointed.

Caudal Fin Ray Count:

750 mm.	10 + 8 = 18	(2 spec.).
	10 + 9 = 19	
503 mm.	7 + 10 = 17	(Text-fig. 13).
	6 + 10 = 16	
115 mm.	9 + 8 = 17	
	9 + 9 = 18	

Additional Characters Worthy of Note: The bases of the posterior caudal haemal arches arise posterior to the center of their respective centra. This is a conspicuous difference from Mugilidae.

2. **Sphyraena borealis** De Kay.

Diagnostic Characters:

The caudal pattern of *Sphyraena borealis* is almost identical with that of *Sphyraena barracuda.* The caudal centra in *S. borealis* are slightly smaller in proportions and the dorsal and ventral raylets are more slender and do not extend as far forward as in *S. barracuda.* Also, the shape of the posterior end of the reduced last neural appears more rounded in all the *S. barracuda* but wider with a square-shaped end in *S. borealis.*

SPHYRAENA BOREALIS.

Material Studied.

Length.	*KOH Cat. No.*	*Caudal Fin Ray Count.*	*Vertebral Count.*
124 mm.	2087	8 + 10 = 18 7 + 9 = 16	12 + 12 = 24
114 mm.	2088	7 + 10 = 17 5 + 9 = 14	
109 mm.	2087	7 + 11 = 18 8 + 8 = 16	

SPHYRAENA PICUDILLA.

Material Studied.

260 mm.	515	7 + 10 = 17 7 + 10 = 17	12 + 12 = 24
230 mm.	514	8 + 10 = 18 8 + 9 = 17	
120 mm.	2090	7 + 10 = 17 5 + 9 = 14	

The *Sphyraena picudilla* material which has been studied and considered as one with *S. borealis* is for the sake of clarity listed above in order to show the similarity of two characters, at least, in the vertebral count and the caudal fin ray count.

SUMMARY.

There is a marked similarity in external characters of the species of Atherinidae, Mugilidae, and Sphyraenidae, which are grouped together under the suborder Percesoces, but the study of their skeletons shows that these families are not as closely related as their external similarities indicate. For example, Atherinidae, considered the most primitive of living Percesoces, has a total vertebral count and a caudal count of almost twice the number found in Mugilidae and Sphyraenidae.

According to the caudal osteological pattern, *Atherina* seems to be less specialized and stands apart from the other Bermuda Percesoces. On the other hand Mugilidae and Sphyraenidae are drawn together.

Hypurals: In young specimens of the three families a 3d ventral hypural is present which is directly below the median line and similar in shape and position to the corresponding hypural in all the Bermuda Isospondyli. In the fully adult percesocids this bone becomes one with the 2nd hypural and in all species the pattern is similar in having two large median fan-shaped hypurals. It will be seen in the table that the species of Bermuda Percesoces, including the young, have fewer hypurals than the Bermuda Isospondyli.

Urostyle: In all species of Bermuda Percesoces the urostyle appears consolidated and there is no evidence of separate segments which are found in all of the Bermuda Isospondyli.

Ray-scales: There are no specialized ray-scales. These are prominent in the more generalized Bermuda Isospondyli: *Elops, Tarpon,* and *Albula,* and less obvious in the other Isospondyli.

The table sums up caudal counts and indicates similarities and differences in the species of Percesoces. This opportunity is taken to tabulate the counts of the Isospondyli of Part I for the purpose of comparison.

TABLE I.

Caudal counts, comparing families of Percesoces and the Isospondyli.

Percomorphi	Hypurals.		Uroneurals.	Vertebral Count.	Caudal Fin Ray Count.
Percesoces	Adult.	Young.			
Atherinidae	4, $\frac{2}{2}$	5, $\frac{2}{3}$	1	43 (22 + 21)	$\frac{19}{18}$
Mugilidae	4, $\frac{2}{2}$	6, $\frac{3}{3}$	1	24 (11 + 13)	$\frac{15}{16}$
Sphyraenidae	4, $\frac{2}{2}$	6, $\frac{3}{3}$	2	24 (12 + 12)	$\frac{18}{19}$, $\frac{17}{16}$
Isospondyli					
Elopidae	9, $\frac{5}{4}$		4	72 to 81 (49to57 + 24to26)	$\frac{18}{16}$, $\frac{19}{16}$
Megalopidae	8, $\frac{5}{3}$		3	57 (33 + 24)	$\frac{16}{13}$, $\frac{16}{14}$
Albulidae	7, $\frac{4}{3}$	7, $\frac{4}{3}$	2 adult. 4 young.	69 (42 + 27)	$\frac{18}{16}$
Dussumieriidae	7, $\frac{4}{3}$	7, $\frac{4}{3}$	3	43 (27 + 16)	$\frac{14}{12}$
Engraulidae	7, $\frac{4}{3}$		3	40 to 42 (20to21 + 20to21)	$\frac{18}{17}$
Clupeidae	7, $\frac{4}{3}$		3	37 to 40 (12to14 + 25to26)	$\frac{19}{16}$

Bibliography.

(For full bibliography refer to Part I).

Agassiz, Alexander.

1878 On the Young Stages of Some Osseous Fishes. *Proc. Amer. Acad. Arts and Sciences*, 1878. n. s., vol. V, whole series, vol. XIII, 2 plates, 32 figs.
(Plate II includes figures of four young *Atherina*, 5, 9, 10, and 11 mm.).

Starks, E. C.

1899 The Osteological Characters of the Fishes of the Suborder Percesoces. *U. S. Nat. Mus.*, vol. 20, pages 1-10.

Whitehouse, R. H.

1910 The Caudal Fin of the Teleostomi. *Proc. Zool. Soc. London*, 1910, vol. II. (Includes short description of *Atherina boyeri* and *Mugil capito*, and also a few general remarks on the Percesoces).

18.

Some Observations on the Feeding Methods of the Vampire Bat.

BARRY G. KING & ROBERT SAPHIR

Department of Physiology, Columbia University

(Plates I-III).

Many superstitions and curious beliefs have been associated with the vampire bat. Anaesthetic, depilatory and anti-coagulant properties have been attributed to the saliva of the vampire. Even at this date the true vampires, *Desmodus, Diaemus* and *Diphylla,* are described in dictionaries and encyclopedias as "blood-sucking" animals. In recent years the work of Dunn (1), Clark (2), Urich (3) and Ditmars (4) has done much to afford scientific information as to the habits of the vampire and to discredit erroneous statements as to its behavior.

For the past five years Ditmars has been making a detailed study of *Desmodus rotundus* in New York City. Observation by him in the natural locale of *Desmodus* gave an opportunity for viewing the results of its work. When humans were bitten during the night, blood stains were always apparent. Ditmars reports a case of a ten year old boy bitten during sleep five times within a week. "He had bled profusely and the earthen floor beneath his slatted bed was blood stained each morning." Cattle frequently showed large blood stains on their hides. "Ropes" of coagulated blood were seen hanging from the necks of horses attacked in their stalls. Such observations were indicative of profuse bleeding. The possibility that saliva of the vampire bat contained an anti-coagulant which might be used for studying some aspects of the phenomena of blood coagulation seemed worthy of consideration. It is well known that certain of the hematophages secrete such substances.

Bier (5), in 1932, reported a fibrinolytic and anti-coagulant action of an alkaline alcohol-ether extract of macerated salivary gland of *Desmodus.* He states that a similar extract of the salivary glands of a single specimen of *Phyllostoma* did not reveal such properties. Bier states that aqueous extracts of the glands of *Desmodus* had no anti-coagulant properties. Samples of rabbit blood to which the aqueous extract were added showed the same coagulation time as the control samples. This does not appear to afford a strong evidence for the implied significance of his observations.

During the preparation of this article the attention of the authors was called to a paper by Pawan (6) in which he states: "Bleeding may be profuse, probably due to an anti-coagulant, which was found present in both the dry and fresh powdered salivary gland substance, and which is capable of hindering coagulation of human blood in greater dilution than 1 in 1,000." Pawan does not give the details of preparation of this extract.

An opportunity for further observation on the method of feeding was made possible by the availability of four specimens of *Desmodus* at the New

York Zoological Park. Four additional specimens were obtained from Trinidad for the investigation of the possible anti-coagulant properties of their saliva, through the kindness of Professor Urich.

The vampires were housed in a large cage, well protected from drafts, without any special attention to maintenance of a constant temperature. The cage was kept scrupulously clean. A fresh supply of drinking water was constantly at hand. The bats were fed defibrinated blood two or three times a week. On the remaining days, except on Sundays when they were starved, they were allowed to feed upon either live fowl, rabbits, guinea pigs or a goat. There was ample room in the cage to permit putting the various animals in with the bats, and yet allow the bats sufficient space to take flight and attain a safe roost if their host became restless.

In order to determine whether an anti-coagulant was normally present in the saliva of *Desmodus* while it was feeding, (1) coagulation time was determined for samples of blood from the bat wounds, (2) the bleeding time of the wounds was noted, (3) the effect of washings from the bats' mouths was tested on freshly drawn cat's blood and (4) the mouths of the bats were examined for clots following the feeding of human blood by means of an eye-dropper.

Method of Obtaining Samples for Determination of Coagulation Time.

The method of presenting the experimental animal to the bats varied for the species. Where fowl were used the initial practice was to bind the wings and legs. The movements of rabbits and guinea pigs were restricted by bandaging them to an animal board. A halter was placed on the goat to prevent it from throwing its head back and injuring the bats with its horns.

It soon became apparent, however, that the vampires were well able to take care of themselves. They were able, in all except a few instances, to bite and feed without disturbing their hosts. Fowl were completely indifferent to their enforced role so that the binding was soon discontinued. In one instance when feeding was interrupted by turning on the light, a rooster got on its feet and walked a few steps, while a bat, standing on its hind legs, its thumbs braced against the leg of the rooster, continued to lap blood from the wound. The goat displayed some curiosity as to the bats when they were moving about, but showed no indication of being aware of being bitten. Occasionally, during the feeding, the goat would contract its panniculus carnosus muscle, causing its hide to quiver, as it might do to shake off flies. Since rabbits and guinea pigs are fairly active in the dark, it was deemed advisable to continue restricting their movements.

After placing the host in the bat cage, the lights were extinguished and a sufficient time was allowed for the bats to get under way with their feeding. Feeding was then interrupted and the animal removed from the cage. An attempt was then made to secure a sample of freely flowing blood either in a small phial or in a capillary tube such as is ordinarily used for determination of coagulation time.

At the outset, it was apparent that the presence of an anti-coagulant would be indicated only if coagulation were delayed for relatively long periods. The experimental conditions were far from ideal. The wounds were frequently contaminated with hair and other foreign material during the process of feeding. In addition there was considerable unavoidable variation between the actual time of the bite, which could not be accurately determined, and the time of collecting the samples. Control experiments for comparison of coagulation time could be of only minor significance since the bites could not be adequately imitated.

Fowl.

The results on fowl were equivocal. All but one of the samples of blood taken from two fowl clotted in 3 to 7 minutes. Blood from a wound made by cutting a small crater with a scalpel clotted in 2 to 6 minutes. One sample from the bat wound did not clot for 50 minutes. Such a result might indicate either that there was a sufficient quantity of active saliva to retard coagulation in only one sample or that there was something unusual in that sample. Blood of fowls does not contain cephalin, and clotting depends upon the addition of tissue cephalin so that there exists the possibility of obtaining samples without "contamination" of the tissue fluid. The use of fowls was discontinued for this type of test so as to rule out such a possibility.

The results of observations made on other species are summarized in Table I.

TABLE I.

Range of coagulation times for the samples of guinea pig, rabbit and goat blood.

Animal.	No. of Animals.	No. of Experiments.	No. of Samples.	Source of Samples.	Range of Coagulation times (Min.).
Guinea Pig.	1	1	5	Incised marginal ear vein.	4-5
			3	Bat wounds.	3-8
Rabbit.	2	2	10	Incised marginal ear vein.	3-10
			6	Bat wounds.	3-10
			1	From blood dripping on wax paper from incision on toe.	5-17
			1	From blood on wax paper from bat wound.	9-20
Goat.	1	3	19	From bat wounds.	1-10

A typical protocol of a test on the goat is given below.

7 P.M. Goat placed in cage; lights extinguished.

9:40 P.M. Feeding interrupted. Two bats were seen feeding on the goat. One old wound on its side had been reopened. Another fresh wound had been made on its back. The old wound was oozing blood; the wound on the back was relatively clean and dry with only a minute amount of blood in the crater-like wound. Samples were taken from site of old wound.

Sample.	*Clotting Time.*
1	3′45″
2	3′50″
3	6′45″
4	6′20″
5	5′17″
6	5′01″
7	3′50″
8	3′50″

10 P.M. Wound on back showed small amounts of clot around edges of crater; no bleeding. The wound was opened by gentle massage of the surrounding area.

Sample.	*Clotting Time.*
1	2′
2	1′10″

After the bats had been feeding, small pools of blood were seen on the floor of the cage; frequently the pelage of the host was streaked with blood. In spite of the evidence of a free flow of blood during feeding, the efforts to obtain adequate blood samples for determination of coagulation time were frequently unsuccessful. On removing the animal from the cage the wounds were usually either relatively dry or showed a slow oozing which filled the crater of the bite, but did not drip from the wound. Occasionally, however, the oozing was sufficient to result in some dripping.

When the flow was inadequate for sampling, gentle massage around the area of the wound would reestablish a slight flow. Clots formed, in the undisturbed wounds and in wounds in which the flow had been reestablished by massage, in 4 to 35 minutes.

In contrast to these results, a wound, inflicted by inducing a leech to feed on the goat, bled for more than an hour. Samples collected from the leech wound showed coagulation times of 7 to 13 minutes.

The Effects of Washings from the Mouths of *Desmodus* on Coagulation Time of Cat's Blood.

After repeated handling the bats would remain quiet when held lightly in a gloved hand. Occasionally they would bite the glove once or twice and then become quiet and feed contentedly from a pipette. When they had become accustomed to handling, washings were obtained from their mouths with the view that if an anti-coagulant were present, it might be possible to obtain a solution of their saliva of sufficient concentration to retard or prevent coagulation of freshly drawn blood.

5 cc. of distilled water was measured into a small container. A few drops were taken up in an eye-dropper and injected into the mouth of a bat. The washings were recovered from the mouth or the lips, returned to the original 5 cc. container and the dropper rinsed in the mixture. The process was repeated six to ten times for each of the four bats. A half-hour

TABLE II.

Coagulation time: cat's blood (carotid artery) and washings from mouths of *Desmodus*.

Sample.	CC. of Blood.	Solution Added.	Am't Solution.	Coagulation Time.
1	3	Saline "washings."	5 drops	4′28″
2	3	" "	3 "	3′33″
3	3	" "	1 "	3′50″
4	3	Distilled Water "Washings."	5 "	2′31″
5	3	Distilled Water "Washings."	1 "	4′53″
6	3	Saline only.	5 "	5′03″
7	3	" "	1 "	6′47″
8	3	NONE (clean & dry).	.....	5′51″
9	3	" " "	.....	6′08″

rest period was allowed and the process was repeated, using 5 cc. of saline solution. Small portions of the 5 cc. of saline washings and the 5 cc. of distilled water washings were added to 3 cc. of freshly drawn cat's blood. Coagulation time was taken when the test tubes could be inverted without spilling the mixture. The results are summarized in Table II. It is apparent that the addition of washings decreased the coagulation time. Similar results have been obtained with human and dog saliva, by Bellis, Birnbaum and Scott (7). Human saliva reduced coagulation time when added to blood in proportions of 1 to 400.

Results of Examination of the Mouths of *Desmodus* after Feeding Freshly Drawn Blood with Pipettes.

To obtain freshly drawn blood for the feedings, the fingers of one of the observers were washed thoroughly with soap and water and then alcohol. Time was allowed for the fingers to dry and a puncture was made with a blood lancet to a depth to permit a generous flow of blood. A portion of the blood was drawn into a clean dropper and transferred to the mouth of a bat. If the bat fed rapidly, two or three portions could be transferred to the bat's mouth in about a half a minute. A clean dropper was then taken, a fresh puncture was made and the process was repeated. The mouths of the bats were forced open gently at frequent intervals and examined for clots.

Results: April 17. Pipetted blood from finger puncture into mouth of bat. Surface of finger was repeatedly cleaned, using a new drop of blood and a clean pipette after 2 or 3 feedings. Bat's mouth gently forced open with forceps. Several small clots were noted and removed.

May 4. Male bat fed on blood from finger punctures. No clots were seen on examination of buccal cavity. A small clot was allowed to form on a finger puncture and was offered to the bat. He ate it readily.

Female—Did not feed well. Only occasional movement of tongue. Swallowing infrequent. As a result some blood collected in mouth. Examination revealed some fluid blood in the rugae palatinae. Small clots were seen on the tongue, hard palate and on the buccal surfaces of the cheeks.

May 10. Male—Fed blood from finger puncture. Examination revealed small clots in mouth.

May 15. Male—Fed blood from finger puncture. Examination revealed good clot after first 3 feedings (less than 1 minute).

Female—Fed for 3 minutes. Clot seen in mouth.

May 20. Two bats fed on blood from finger puncture. Clots seen in mouths after feeding.

Depth of the Bat Bites.

Tissues surrounding wounds at which bats had been feeding were removed and fixed for sectioning and histological examination. Sections were made of the wounds in a pigeon, a chicken and a guinea pig.

The bite in the guinea pig extended through the four layers of the epidermis and the two layers of the dermis but did not involve the panniculus adiposus. Thus, the bite may be said to be skin deep.

The combined thickness of the dermal and epidermal layers in the guinea pig are from two to four times as thick as they are in the pigeon. The panniculus adiposus in the guinea pig was of a fairly constant depth but in the pigeon it was variable although always present in some degree. In the pigeon the panniculus adiposus and even a few of the outermost muscle bundles were removed. Although a greater number of differentiated

layers were removed in the pigeon, the bite was of approximately the same depth as in the guinea pig.

The bite in the chicken extended into the stratum reticularis of the dermis. As the dermis of the chicken in that area was thicker than that of either the guinea pig or the pigeon, a bite of approximately the same depth did not reach the adipose layer.

Conclusions.

While it has been reported that extracts of the salivary glands of *Desmodus* have anti-coagulant properties, the results of these experiments fail to reveal any evidence that an anti-coagulant plays a part in the normal feeding process of the vampire. The difficulty in obtaining adequate samples of the blood, the relatively rapid clot formation in the wounds after feeding has been interrupted, and the presence of clots in the mouths after dropper feedings, are strong indications that the rapid flow of blood during feeding is due to the nature of the bite and the massage by the tongue.

The view that since vampire bats are hematophages they are supplied with a saliva having anti-coagulant action may have arisen through teleological reasoning. Slicing the highly vascular dermis insures a fairly good flow of blood. If the flow is free, the bat laps the blood scarcely touching the tissues; if scant, the bat licks the wounds (1). The blood stains on the pelage and on the ground may be accounted for by dripping of the wound when the flow is kept going during the feeding.

Acknowledgement is due Dr. R. L. Ditmars for his whole-hearted cooperation in carrying out these studies. Dr. Ditmars offered his own specimens of *Desmodus rotundus* for the preliminary observations in which he collaborated; he assisted in helping obtain the additional specimens from Trinidad and made many helpful suggestions as to their handling and care. The authors also wish to express their indebtedness to Professor Ernest L. Scott for the photographs and to Mr. William Bridges for his encouragement and helpful suggestions.

BIBLIOGRAPHY.

(1) DUNN, L. H. 1932. Experiments in Transmission of *Trypanosoma hippicum* Darling with the Vampire Bat, *Desmodus rotundus murinus* Wagner, as a Vector in Panama. *Journ. Prev. Med.*, Vol. 6, 415-424.

(2) CLARK, H. C. 1934. Personal communication. See Ditmars & Greenhall, 1935, cited below.

(3) URICH, F. W. 1934. *Reports of the Board of Agriculture of Trinidad and Tobago*, May and June reports.

(4) DITMARS, R. L. & GREENHALL, A. M. 1935. The Vampire Bat. *Zoologica*, Vol. XIX, No. 2, 53-76.

(5) BIER, O. G. 1932. Action Anticoagulante et Fibrinolytique de l'extrait des Glandes Salivaires d'une Chauvesouris Hematophage (*Desmodus rufus*). *C. R. Soc. Biol. Paris*, Vol. 110, 129-131.

(6) PAWAN, J. L. 1936. Transmission of paralytic rabies in Trinidad by the Vampire bat, *Desmodus rotundus murinus* Wagner. *Ann. Trop. Med.*, 30, 101-130.

(7) BELLIS, BIRNBAUM & SCOTT. 1932. Effect of Saliva on Coagulation of the Blood. *Proc. Soc. Exper. Biol. and Med.*, XXIX, 1107-1108.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Training a vampire bat to feed from a medicine dropper, using defibrinated blood. The bat is held lightly between the thumb and the first two fingers.

Fig. 2. The bat feeds contentedly from the dropper. It may be noted that the mouth is open and the lips are not in contact with the pipette. The tip of the tongue may be seen touching the end of the dropper.

Plate II.

Fig. 3. Lapping blood from the site of a blood puncture. The bat evidences no annoyance at the handling. All his efforts are directed toward obtaining the blood.

Fig. 4. Finishing the drop of blood. The spear-shaped tongue is well extended in lapping the blood.

Plate III.

Fig. 5. Microphotograph of a vampire bat bite in the guinea pig. The bite extended through the epidermis and the dermis.

Fig. 6. Microphotograph of a bite in the pigeon. The epidermis, dermis, panniculus adiposus and even a few of the outermost muscle bundles were removed.

FIG. 1.

FIG. 2.

SOME OBSERVATIONS ON THE FEEDING METHODS OF THE VAMPIRE BAT.

FIG. 5.

FIG. 6.

SOME OBSERVATIONS ON THE FEEDING METHODS OF THE VAMPIRE BAT.

19.

Growth of Galápagos Tortoises, *Testudo vicina,* from 1928 to 1937.

CHARLES HASKINS TOWNSEND
New York Aquarium.

(Plate I).

The colonies of Galápagos tortoises (*Testudo vicina*) established by the writer under the auspices of the New York Zoological Society may be reported as in prosperous condition. The tortoises are now in eight groups. Those within the limits of the United States were originally a little more widely distributed.

During the nine years they have been under our observation, the animals have made notable growth. When distributed for observation in 1928, the average weight of the 100 tortoises considered in this paper was a little more than 18 pounds. At present it is more than 134 pounds. A dozen individuals weigh nearly 200 pounds each, and a score weigh more than 160 pounds.

In the table showing growth we have not included all the tortoises originally reported upon (see *Zoologica,* Vol. IX, No. 13; June 1, 1931). A few lost the copper numbers used to identify them, and a few are temporarily out of reach. The 100 herein reported upon have individual records without error.

TABLE I.

Growth of *Testudo vicina* at all stations.

Place.	Number of Tortoises.	Total lbs., 1928.	Average lbs., 1928.	Total lbs., 1937.	Average lbs., 1937.
San Diego, Cal.	18	425	23.61	2,492	138.44
San Antonio, Tex.	7	99	14.14	1,078	154.00
Houston, Tex.	8	72	9.00	1,312	164.00
New Orleans, La.	7	100	14.28	1,010	144.28
N. Miami, Fla.	39	908	23.28	5,305	136.02
Bermuda	9	56	6.22	864	96.00
Honolulu, T. H.	6	177	29.50	1,129	188.16
Sydney, Australia	6	19	3.16	306	51.00
	100	1,856		13,496	

Being widely scattered, the tortoises have not all been treated alike. Their food has varied somewhat from place to place, and some have still to be housed in winter. There were losses from feeding vegetables on sandy ground, post-mortem examinations showing sand impacted in the colon.

The following records made at Houston, Texas, for the years 1928 and 1936 show the growth in dimensions as well as weight.

TABLE II.

Increase in dimensions and weight of eight *Testudo vicina* at Houston, Texas, between 1928 and 1936.

1928.

No.	Length, Inches. Straight.	Length, Inches. Curved.	Width, Inches. Straight.	Width, Inches. Curved.	Height. Inches.	Weight, lbs. 1928.
90	13⅛	17½	11	17¼	7¼	13
91	12½	15¾	9½	14⅝	5⅞	10
92	11⅛	14½	8½	13¼	5¼	7
93	12	15¾	9¼	14¾	6	8
94	11¾	14⅝	8⅞	14	5⅝	7
95	12¼	15½	9½	15	6	10
98	10¾	13½	8½	13	5⅛	7
99	12½	15¾	9⅝	15¼	6⅛	10
						72

1936.

No.	Length, Inches. Straight.	Length, Inches. Curved.	Width, Inches. Straight.	Width, Inches. Curved.	Height. Inches.	Weight, lbs. 1936.
90	25	40	27	40	20	179
91	24	38	24	40	20	154
92	23	35	21	38	19	150
93	23	35½	22	38	19	149
94	23½	37	22½	39½	19¾	162
95	24	38	24	38	19	155
98	24	41	26	42	21	183
99	25	40	24	41	20½	180
						1,312

The tortoises housed in winter, and uniformly dark-colored, developed very rapidly a conspicuous white growth-ring on the border of each horny plate when turned out on grass. This treatment produced a new ring each year, indicating age; growth slow in winter, rapid in summer. Tortoises in southern Florida, having access to grassy ranges at all times, were never lacking a very faint whitish ring. However, tortoises of similar size and weight had equal numbers of rings, regardless of treatment. For photographs of growth rings, see *Zoologica*, Vol. IX, No. 13, page 469.

The horny plates of the tortoises expand with the growth of the animal, by adding rings of new material around their margins.

In the younger animals, at least, age is indicated by number of rings. In tortoises of large size the rings tend to flatten and are hard to count. At-

tempts at counting rings on tortoises exceeding 160 pounds in weight indicate that they are about 20 years old. All males of that size or a little over have within the past three years partly acquired the concave plastron that *must* precede breeding age. This hollowing out is still increasing and we assume that maturity is near. Giant tortoises are long-lived. There are records of a few that exceeded 150 years. The breeding age may not be attained until they are between 20 and 25 years old.

EXPLANATION OF THE PLATE.

Plate I.

Fig. 1. *Testudo vicina.* Specimen No. 10 at North Miami, Florida. Weight, 165 pounds. As nearly as can be judged by ring growth, this tortoise is about 20 years old and the hollowing of the plastron, indicating an approach to breeding age, is quite noticeable.

FIG. 1.

GROWTH OF GALÁPAGOS TORTOISES, TESTUDO VICINA, FROM 1928 TO 1937.

20.

Lymphocystis Disease in *Angelichthys.*

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&

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(Plates I-III).

A cutaneous disease in fishes, particularly in flounders, characterized by the formation of small, irregular, solitary or confluent nodules of grayish-white color has been studied by a number of investigators (Woodcock, 1904; Awerinzew, 1909; Weissenberg, 1914; Benisch, 1937). Earlier studies indicated that this peculiar disease in fishes was caused by some form of *Cnidosporidia.* More recent studies tend toward an explanation that an unknown virus may be the principal causative factor (Weissenberg, 1914; Benisch, 1937). The small nodules forming the visible features of the disease lie directly below the epithelium of the skin. Histologically the lesions exhibit an immense hypertrophy of individual cells of the host. Hypertrophied cells may show a diameter many times the normal. The cytoplasm of such cells is surrounded by a dense cell membrane. The cell nucleus is also enlarged and stains paler than normal. Cell inclusions of various sizes, shape, and arrangement can be demonstrated in the cytoplasm, and these are regarded as the evidence of the activity of a living though invisible virus which has initiated striking structural changes in the cells.

Two instances of lymphocystis disease occurring in the adult common angelfish (*Angelichthys isabelita*) have come under observation recently at the New York Aquarium. These fishes occupied a large salt-water tank with about ten other angelfishes of the same species. The victims of the disease were apparently in good health at the time they were received at the Aquarium, and it is our impression that the onset of the infection took place during the period of their captivity.

On inspection both angelfishes presented numerous dark grayish patches and nodules on the surface of the skin, most conspicuous in the region of the base of fins and at the base of the tail. In some areas the individual nodules were as much as one and one-half centimeters in diameter. Plate I, Figure 1, shows one of these nodules, somewhat enlarged, which was removed for biopsy from the region of the dorsal fin, and in the photograph the mass is seen as attached to one of the rays of this fin. Plate I, Figure 2, shows the same specimen cleared in cedar oil, which permits a transillumination of the specimen, in order to show the small pin-point black dots covering the surface of the tumor and often giving it a dark hue. Each black dot represents a single or a group of corial melanophore cells of the

skin overlying the growth. On cross-section of the tumor, the tissue is found to be grayish-white in color, and very soft. The nodules are confined strictly to the skin, and do not invade the deeper lying muscles. The tumor tissues removed for biopsy were preserved in 10% formalin, and the sections were prepared by the paraffin method. The stains employed were eosin and methylin blue and hematoxylin and eosin. It is realized that other forms of fixation and staining will have to be used in future studies, in order to insure a more satisfactory analysis of cytological detail, particularly from the standpoint of cell inclusions.

Plate II, Figure 3, and Plate III, Figure 5, are the photomicrographs of the structure of one of the skin nodules. The overlying epithelium is considerably thickened and hyperplastic, attaining a depth of from fifteen to twenty cells. Numerous mucous cells are found in the epithelium, and in some fields they are greatly distended, almost cystic in appearance. Below the epithelium lies a thickened corium, containing scattered melanophores. It is just below this point that the characteristic lesion of lymphocystis disease becomes apparent. The tissue here assumes the appearance of a spongy network of fibrous compartments containing hypertrophied cells varying greatly in size and contour. These enormous cells (Plate II, Figure 4, and Plate III, Figure 6) lie in a thickened tissue framework composed of elongated connective tissue cells, at times hyaline in appearance. The hypertrophied cells contain a fine granular cytoplasm with some basophilic material at the periphery. In many sections cut at the proper level, a pale-staining nucleus with one or two nucleoli can be distinguished. The larger cells, measuring often as much as 468 microns, show irregular and pale nuclei with beaded and festooned chromatin collections at the periphery. Of great interest was the finding of bright-staining eosinophilic hyaline-like bodies in some of these distorted nuclei. Such red-staining intranuclear masses resemble inclusion bodies characteristic of certain virus diseases. Further studies with different fixations and staining technique will be necessary to determine this point. Where the fixation of the tissues has been uniform and satisfactory, it is seen that the largely hypertrophied cell has a distinctly thickened cell membrane. In many areas the cytoplasm of large diseased cells has shrunk away from its surrounding fibrous structures.

An impression is gained that a low grade inflammation accompanies this hypertrophic process affecting the cells of the host, as there are many collections of lymphocytes in the various microscopic fields examined, such as is seen for example in Plate III, Figure 5.

Summary.

Lymphocystis disease occurring in the angelfish (*Angelichthys isabelita*) is described, and structural arrangement of the characteristic cutaneous nodules is discussed.

Bibliography.

Awerinzew, S.

1909 Studien uber parasitische Protozoen. II *Lymphocystis johnstonei* Woodc. *Arch. f. Protistenk.* Bd I4.

Benisch, J.

1937 Uber das Auftreten der Lymphocystis—Krankheit bei einigen Korallenfischarten. Wochenschrift fur Aquarien und Terrarienkunde. 26/27, 34. Jahrgang, Braunschweig, page 380.

Weissenberg, R.

1914 Uber infektiose Zellhypertrophy bei Fischen (Lymphocystiserkrankung). Sitzungsberichte der Königliche Preussischen Akademie der Wissenschaften. XXX: 792.

WOODCOCK, H. M.
1904 Note on a remarkable parasite of the Plaice and Flounders. *Rep. Lancashire Sea-fisheries for* 1903.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. A nodule of lymphocystis tissue removed for biopsy, enlarged eight times. It is attached to a fragment of the dorsal fin ray.

Fig. 2. The same nodule, slightly lower magnification, cleared in cedar oil, transilluminated to show the minute black dots representing melanophore cells of the skin overlying the tumor. x 7.

Plate II.

Fig. 3. Section of spongy network of lymphocystis disease lying below thickened epithelium. Hypertrophic cells are seen lying in fibrous tissue compartments. x 65.

Fig. 4. A single hypertrophied cell. x 250.

Plate III.

Figs. 5 and 6. Hypertrophied lymphocystis cells. x 125.

FIG. 1.

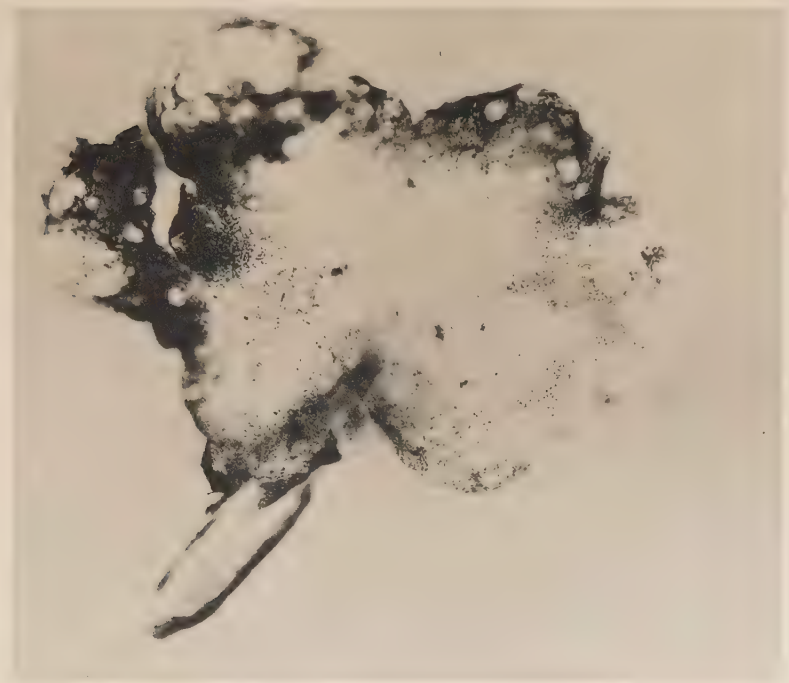

FIG. 2.

LYMPHOCYSTIS DISEASE IN ANGELICHTHYS.

FIG. 3.

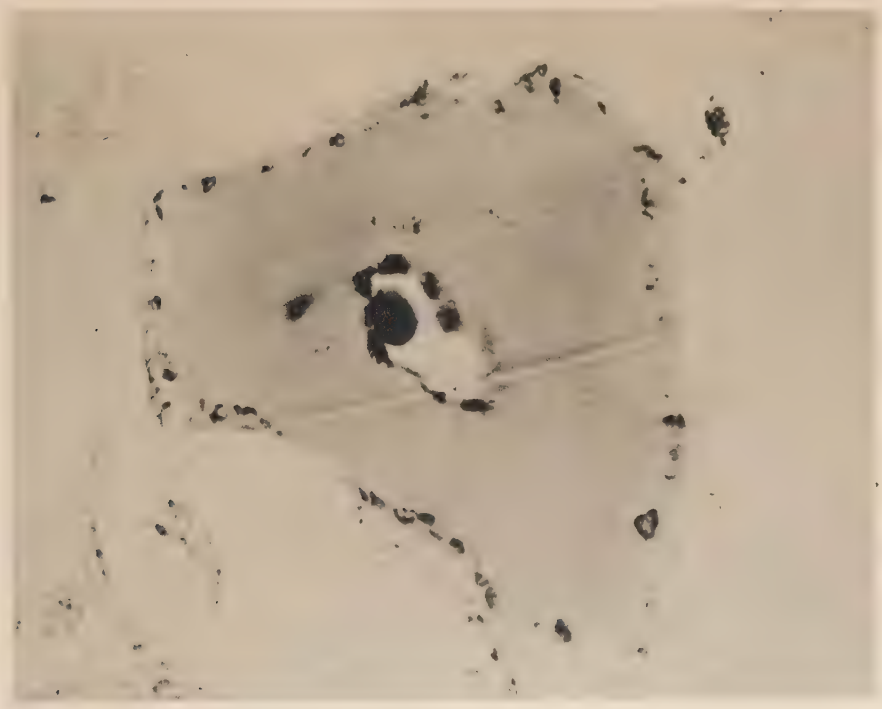

FIG. 4.

LYMPHOCYSTIS DISEASE IN ANGELICHTHYS.

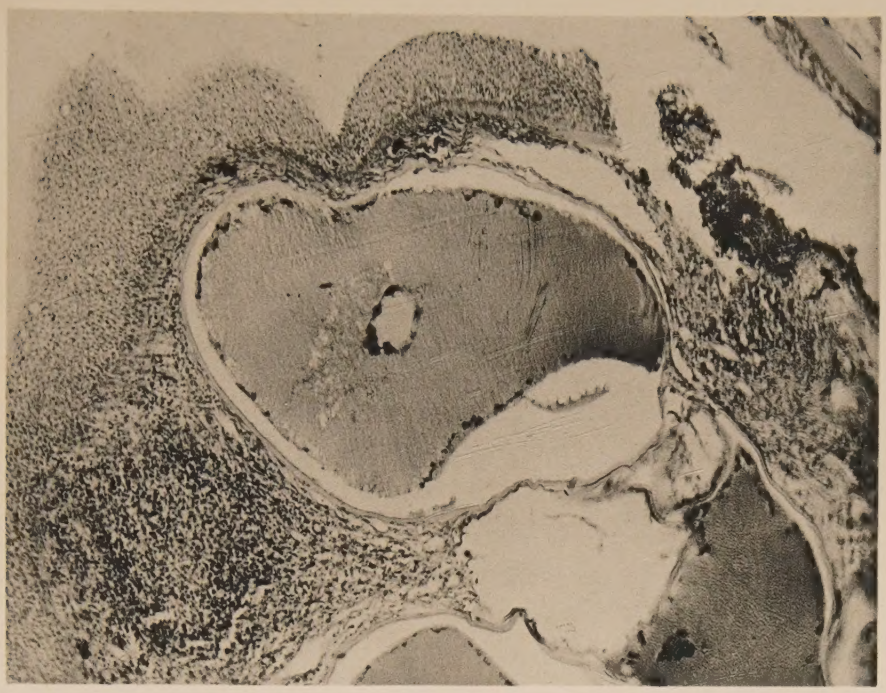

FIG. 5.

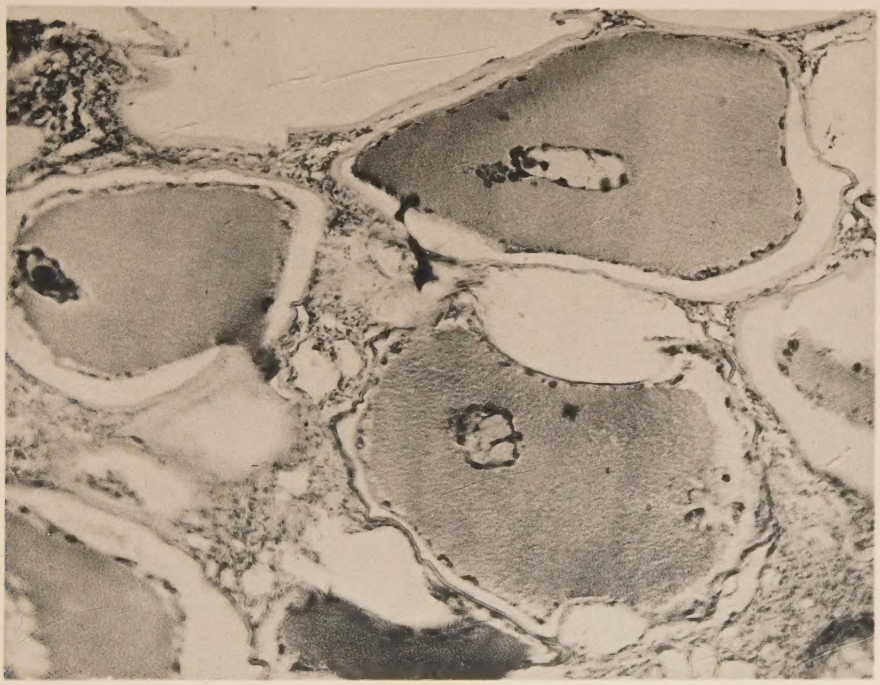

FIG. 6.

LYMPHOCYSTIS DISEASE IN ANGELICHTHYS.

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